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Note on Train Speeds,

by Lionel WIENER,
Professor at the University of Brussels.

1st PART.

Generalities relating to speeds.

INTRODUCTION.

The public — the public at large — always takes a keen interest in train speeds, possibly because there is a sporting touch about them, which strikes the imagination. The railways themselves get a certain amount of publicity out of it and keep up public interest by communicating to the general press details of any sensational runs made in special circumstances.

In addition, the competition between railway companies has frequently driven them to shorten the time between towns served by two or more railways, a competition which has occasionally ended in actual racing. After the railways concerned have obtained all the publicity possible, the races ceased to have any justification and, as they were very costly, agreements were come to in accordance with which the speed of the trains was restored to something but slightly higher than it was before the sudden awakening which demonstrated what was — technically — possible. It is true the public grumbled somewhat, but as there was no other means of transport..., no notice was taken.

This happened after the railway races from London to Scotland, those from Camden to Atlantic City (U. S. A.), and even before the agreement between the South Eastern Railway and the London Chatham & Dover Railways as regards the London to Dover traffic.

But circumstances have changed recently. If the general crisis has affected the railways as well as other industries, its

effects have been aggravated by a series of crushing social burdens imposed on the railways by all governments — generally without compensation — because it is easy to give way to mob pressure and because it is convenient to be able to collect taxation from the railways, simply by increasing the fares.

In addition, new means of locomotion — aircraft and motor cars especially — have come into ordinary use. The railways have had to wake up from their too long lethargy and to find means for defending their interests against these redoutable, because favoured, adversaries. They have thus found — I was going to say with astonishment — not only that they could defend themselves but even in certain cases that they could attack the enemy in spite of the undisputable advantages the latter enjoyed owing to the absence of appropriate legislation.

Amongst the methods made use of, in addition to the increased comfort of passenger trains and the simplification of goods traffic, was the reorganisation of all train services, commencing with the main line expresses, then the ordinary passenger trains, and finally the goods trains.

This is one of the reasons why, especially during the last two years, there is a general speeding up of the trains which the public appreciates and which is reflected in the Australian slogan « back to the railways ».

Road motor competition. — As road motor competition has been so harmful that, to meet it, the railways have speeded up their services, it is advisable to go over the circumstances which have led to the present position, so as to appreciate the palliatives used to lessen its drawbacks.

From the introduction of railways, which have needed considerable capital to build, certain privileges and often pecuniary assistance were granted them, either in the form of guaranteed interest or of a non-repayable subsidy. In addition, they were generally awarded a traffic monopoly within a specified area. In exchange, various burdens were laid on them. They were called upon to convey, free of charge, a whole series of traffics for the State. They were forced to build their lines on their own fenced-in property, and to fit signals throughout. They had to submit their timetables and fares to the competent authority for approval and somehow a satisfactory *modus vivendi* was arrived at.

But if the monopoly either of right or of fact had its advantages, it also had its drawbacks. As the public were forced to use the railways, the latter only improved their operating methods when they found it financially advantageous to do so, and as a result the country services, for example, were frequently many years behind what they should have been ; out of date and unsuitable stock was relegated to such services, there were too few trains and they ran deplorably slow.

The social charges imposed on the railways were the first causes of tardy awakening. In order to meet them, it became necessary to increase gross earnings and to economise. But, above all, it was the rapid development of road motor traffic since the War that forced the railways, if they were not to go out of business, to rejuvenate their operating methods.

After the private cars, which took away a far from negligeable number of 1st and 2nd class passengers, motor buses were introduced and these appropriated the lower classes of passengers whereas motor lorries took the goods. As there was complete lack of foresight on the part

of the authorities as to the legislation to be applied to this transport, which was destroying the roads built at the cost of others, as they were not obliged to fence the roads they used nor to provide at their own cost suitable signalling, nor to convey certain traffic either free or at reduced rates like the railways, the latter found themselves in a difficult position to meet this competition.

To all this should be added the attraction of novelty. It is quite possible that, had the situation been reversed, and had railways appeared *after* motor traffic instead of before it, they would have been found to have innumerable advantages : more comfort, more leg room — appreciable on long journeys — and almost complete safety. Add to this the fact that one can move about the train while it is in motion instead of having to stay in the same seat, as in a motor car and that one can read and work, which is impossible in motor cars or coaches.

But it was not so ; railways were the older of the two. They had therefore to fight their battle against quick and comfortable motor vehicles, with out-of-date stock which frequently was 20 to 30 years of age and with timetables as antiquated as the vehicles.

The position was similar to that of the theatre managers endeavouring to compete with their old and obsolete theatre and their out of date customs (attendants expecting to be tipped, interminable intervals between acts) against new palaces showing cinematographic films at low prices.

The position was complicated by the general slump which made it difficult to raise the funds needed to modernise stock and methods. But in spite of all, the railways have undertaken the task, and the increase in train speed is playing a great part in the work.

CHAPTER I.

Means used by the railways to meet road competition.

I-1. — **Substitution of metal carriages for wooden ones.** — This substitution, of special value in the event of accidents, is being carried out. It is a moot question whether it is well timed and whether it is not more urgent for instance, to forbid any system of lighting other than by electricity — the cause of fires with many casualties after a number of accidents — and to hasten up the fitting of goods trains with continuous brakes.

The use of all-metal stock is obviously advisable, but is it to retain its present form ? As it weighs as much as 20 to 25 % more than the stock it replaces, the weight per passenger is greater and it is to be wondered how certain express trains with a full locomotive load, are to be hauled when business picks up and the trains recuperate their former traffic.

Road traffic has taught useful lessons, and has shown that lighter vehicles (but of sufficient weight) may be satisfactory at high speeds.

I-2. — Increased comfort has become the rule and has been applied not only to Pullman and Ist class cars, but also to the others, usually with an increased weight per passenger, which affects the speed of the trains. This can be altered to a certain extent and the work done in this connection by the *London Midland & Scottish Railway* in designing more comfortable seats without increased weight has produced notable results.

Obviously, the question arises as to whether an express « de luxe » train pays its way or is simply an advertising stunt to draw the attention of the public to the services given by the company. While

each case is a matter of appreciation, a striking example is the *XXth Century Limited* which used to cover the 1546 km. (961 miles) between New York and Chicago in 20 hours, and has since been speeded up. Normally a relief was run before it and the number of passengers was such that the latter had also to be run in several parts. The supplement charged by the Company was 29 cents per mile plus 25 cents for the Pullman Company (at the time 3½ d. per mile).

A 12-car train weighing 900 tons carrying 123 passengers with mails, luggage and parcels earned $ 3 927 (then £ 1 080), If a daily average of 100 passengers per train be reckoned on, the annual profit after deducting all costs (repairs and upkeep of fixed plant and rolling stock, operating costs, sinking fund, wages, etc.) exceeded £ 500 000.

I-3. — **Tariff rebates and facilities** draw passengers and freight to the railways, but they are outside the scope of this article.

I-4.— **Railcars.**— Owing to the remarkable results of road traffic, the railways have adopted some of its features. Although they themselves have undertaken road motor services, they have also revived railcars which have been used at intervals since the beginning of railways, and on each occasion, for different reasons. The old Belpaire and other steam cars replaced heavy trains conveying few passengers by a lighter and cheaper service. Today, the reasons for using railcars are as different from the earlier ones as are the means available for attaining them.

Undoubtedly, in certain cases, the direct economy resulting from the substitution was alone considered. More often however, the object is to give better service by means of several trips of the railcar.

Finally, in other instances, slow or semi-express trains which the public was ceasing to patronise — with reason — were replaced by faster (1) stopping or semi-express trains. The results have been so encouraging that a much greater advance has been made, as for example on the Berlin-Hamburg and the Paris-Deauville lines, by substituting comfortable railcars for the fastest « F. D. trains ». We have still to learn what the operating costs will be when the experimental period is over and these fast and powerful railcars have been in everyday service for some time.

This experiment is a wise one and, if its promise is fulfilled, should help to reorganise express train working, as it would enable the railways to use road transport methods whilst retaining their own unquestioned advantages as regards comfort, safety and punctuality in all weathers.

The question is still an open one, as except for tests undertaken in various countries, only three countries have so far introduced normal services using fast railcars.

Up to the present, the maximum speed

(1) The French State Lines have introduced « Michelines » on the Argentan to Granville line; they save an hour on previous express timings. There have only been 24 tyre punctures in 100 000 km. (62 000 miles).

The French Nord Railway uses « Michelines » between Creil and Beauvais and the time for the 88 km. (54.7 miles) from Paris to Beauvais has been reduced from 2 to 1 1/4 hours. The 37 km. (23 miles) between Creil and Beauvais take 33 minutes, including three intermediate stops. The rail motor car services have been extended to Valenciennes.

On the French Midi, 90-H. P. Diesel rail cars seating 55 passengers are used and can run up to 100 km. (62 miles) an hour on the level, like the main line trains.

authorised in Germany had been 100 km. (62 miles) an hour for the « D » trains and 110 km. (68.4 miles) an hour for the « F. D. » trains. In the event of late running, the maximum speed allowed on the Berlin-Hamburg line alone was 120 km. (74.6 miles) an hour, which is the maximum in France also.

To enable this to be done, the distance between distant and home signals had to be increased from 765 to 1200 m. (836 to 1312 yards), a sufficient braking distance for a speed (as yet unauthorised) of 150 km. (93 miles) an hour.

The railcar (1) covers the 178.1 miles between Berlin (Lehrte) and Hamburg in 138 minutes on the outward, and 140 minutes on the return journey, i.e. at a speed of 124.6 and 122.8 km. (77.4 and 76.3 miles) per hour respectively (2), a marked progress even over that of the « F. D. » trains (3).

The French railcar is a Bugatti (4): it has been put on to the Paris-Deauville service and covers the 221 km. (137.3 miles) in exactly 2 hours, at the average speed of 110.5 km. (68.7 miles) an hour (1). Much higher speeds are possible with it ; indeed, during the trial runs on May 5th between Connerré-Beillé and Le Mans, it reached a speed of 172.1 km. (107 miles) per hour.

It is intended, after the Summer season, to use it for the special boat trains between Paris, Cherbourg and Le Havre.

The Dutch Railways have ordered eighty 410 H. P. (2) articulated Maybach-Diesel railcars, able to maintain a speed of 120 km. (75 miles) an hour, although in actual service it is not intended to run faster than 100 km. (62 miles) an hour.

The Reichsbahn are awaiting delivery of a number of slightly different railcars, each with two trailers, for working in the Cologne district (3) and of others for secondary lines (4).

The Union Pacific R. R. is working on the same lines and has ordered articulated units with three bodies carried on four

(1) The car is a twin articulated unit driven by two 12-cylinder, 410-H. P. Maybach Diesel motors. The unit is 40.50 m. (133 feet) long, and weighs 81.2 t. (79.5 Engl. tons) in working order. There are 102 2nd class seats; the weight therefore works out at 796 kgr. (1 754 lb.) per seat.

(2) Leaves Berlin at 8.02 a. m. and Hamburg, at 3.16 p. m.

(3) The « F. D. Züge » (through express trains) leaving Hamburg at 7.18 a. m. and Berlin at 6.5 p. m., take 165 and 163 minutes respectively for the trip, and average 104.3 and 105.4 km. (64.8 and 65.5 miles) an hour. They have just been speeded up and the journey reduced by a quarter of an hour.
Intermediate expresses have been speeded up by half an hour. They now take 3 hours 20 minutes and run at an inclusive speed of 86 km. (53.4 miles) an hour.

(4) This car weighs 23 t. (22.6 Engl. tons) and carries 52 passengers; weight per passenger: 442 kgr. (975 lb.). It is carried on two double bogies, each of 2 + 2 pairs of wheels. It is 23 m. (76 feet) long, and 2.85 m. (9 feet 4 in.) wide.
The four 200-H.P. motors (a total of 800 H.P.) use a benzol-alcohol mixture.

(1) The journey has been reduced from 2 h. 28 m. to the round 2 hours.

(2) These units are fitted with V-type Maybach 12-cylinder engines at 140 r. p. m. The tare weight is 60 t. (59 Engl. tons).
As there are 48 second-class and 112 third-class seats, the weight and horsepower per seat are 380 kgr. (838 lb.) and 5.4 respectively.
The overall length is 55 m. (180 feet).

(3) The maximum speed of these cars is 105 km. (65.2 miles) an hour.
The tare weight is 42 t. (41.3 Engl. tons) for 45 passengers in the motor coach and 77 t. (75.8 Engl. tons) for 115 passengers in the trailers.

(4) Twenty 175-H. P. Maybach cars with mechanical drive, for the Düsseldorf-Crefeld line, have double bogies. Deadweight: 28 t. (27.5 Engl. tons) for 63 passengers. Maximum speed: 80 km. (50 miles) per hour.
Ten of 120-H.P., with same drive, are four-wheeled and weigh 14.5 t. (14.3 Engl. tons). Ten others of 150-H. P. weigh 17 t. (16.7 Engl. tons).

bogies, which should be able to run at 177 km. (110 miles) an hour. However, in practice 90 miles only are to be attained.

Punctuality. — Punctuality at all speeds is a valuable factor in drawing traffic to the railway, and has become so general that it is not necessary to quote more than a few examples. Thus in three months, the « Cheltenham Spa Flyer », the fastest train in the world, only lost 7 1/2 minutes on its timing. Other trains have arrived on time after sensational runs. For example, in September 1932, owing to a derailment in Scotland, which blocked both the up and down lines, the morning express from Edinburgh to London had to be diverted via St. Boswell and Kelso over a section with 32 km. (20 miles) of single-track line. Without awaiting it, the rake of vehicles which is usually added at Newcastle left for London at the usual time. The Scottish portion arrived at Newcastle 37 minutes late, caught up the first part of the train at York and arrived in London (King's Cross) 2 minutes before time [1].

Such punctuality is now the rule. Last year, for instance, the « Broadway Ltd. » (U. S. A.) ran to time 362 times out of a total of 365. In March 1933, 99.6 % of the 50 437 booked trains and 5 767 specials of the New York zone of the Pennsylvania R. R. arrived punctually.

The average number of late trains was therefore 4 per 1000 only.

Punctuality in working the trains is due partly to better and more scientific maintenance of the fixed equipment and rolling stock, and also, and possibly even more so, to the progressive operating methods.

I-5. — **Speeding up.** — The Companies' efforts have been directed notably to improving the speed and punctuality of their trains ; they have carried out a program of general acceleration affecting both slow and express trains.

Thus, each year shows progress over the previous one [1]. Figures relating to 1932 are as follows (See Table 1).

1933 has shown a considerable advance over the figures given in this table.

I-6. — **The publicity** the railway companies obtain from speed is valuable. During the successive accelerations of the « Cheltenham Spa Flyer », for example, the banks of the line were crowded with people who wished to see the train pass, and the photographers and collectors of autographs from the staff ran into thousands. The *Great Western Railway* played on this enthusiasm and issued special tickets from London to Swindon and return by the « Flyer ». From the first day it ran, the corridors have been crowded with passengers checking the speeds, watches in hand.

An important French railway expert connected with one of the leading railways wrote that « ....for railways, it is a » question of collective speed : I mean » by this that it is not a question of » sporting exploits like that which con- » sists in running one or two ultra-light » trains on easy lines and at extraordin- » ary speeds, such as one from Swindon » to London at an average speed of 125 » km. (77.7 miles) an hour, downhill all » the way and with a maximum weight of

[1] This *London North Eastern* train left Edinburgh at 7.55 a. m. and covered the 70.8 km. (44 miles) from Darlington to York in 36 minutes. It left York only 5 minutes late, so that it was easily able to arrive in London before time.

[1] Extract from *Nord-Magazine*.

TABLE 1.

HIGHS-PEED RUNS ON THE FRENCH RAILWAYS IN 1932 [in km. (*in miles*) per hour].

RAILWAY.	Runs at average speed of				Total train-km. (*train miles*) run at average speeds of		
	80 to 89.9 km. (*50 to 55.9 miles*).	90 to 94.9 km. (*56 to 58.9 miles*).	95 to 99.9 km. (*59 to 62 miles*).	Over 120 km. (*62 miles*).	90 to 94.9 km. (*56 to 58.9 miles*).	95 to 99.9 km. (*59 to 62 miles*).	Over 100 km. (*62 miles*).
Nord	109	59	...	4	8 797 (*5 466*)	95 (*59*)	801 (*498*)
Est	86	28	8	1	5 371 (*3 337*)	...	...
Alsace-Lorraine . . .	67	15	1	...	1 377 (*856*)	150 (*93*)	...
Paris-Lyons & Mediterranean.	61	...	1	...	...	...	...
Paris-Orleans	48	10	2	...	1 116 (*693*)	231 (*143.5*)	...
Midi.	25	3	...	...	401 (*249*)	...	...
State	68	11	2	...	1 304 (*810*)	279 (*173*)	...
TOTAL. . .	464	126	14	5	18 366 (*11 411*)	725 (*450.5*)	801 (*498*)

» 230 tons, a feat which it would be » impossible to accomplish on the down » journey. »

No more need be said to confirm the utility of running this train, since so interesting a railway review as *Nord-Magazine* has given it such valuable publicity.... in spite of the Nord having so remarkable a number of fast trains of its own.

Concerning the sense of the quotation, it is hardly fair to consider a regular public service subject daily to all difficulties of ordinary operation as a sporting exploit. In fact, during the first ten months of its existence (which ended on December 3rd, 1932), the « Cheltenham Flyer » was 634 minutes late at the end of its 306 journeys, an average of 21/10th minutes per journey. During this period, it arrived punctually 172 times and 134 times late during the periods of heavy seasonal traffic and in foggy weather. Such a result, maintained throughout the year, has nothing to do with sport, and shows a noteworthy regularity of operation.

Finally, if it is true that the « Cheltenham Flyer » could not maintain such a schedule in the opposite direction, the down 5 p. m. train covered on September 20th, 1932, the 77.3 miles from London to Swindon (start to stop) in 60 minutes, i. e. at the average speed of 124.34 km. (77.28 miles) per hour over a section which, to refer to the quotation, « rises all the way ».

To sum up, each time a train performs

a remarkable run, the press devotes long articles to it. These marks of interest should be noted.

This has been put into practice by the introduction of « mystery trains » in England first, next in France and in Belgium.

However, the public has probably never taken so much interest in the speed of trains as during the racing of the *East* and *West Coast Routes,* first in 1888, from London to Edinburgh, later in 1895 from London to Aberdeen. This latter was the more interesting, because it was a question of getting to the Kinnaber signal box before the competing train, both trains having to run on over a common section of 61 km. (38 miles) (1) leading to Aberdeen. The whole population of Great Britain — and of the Colonies — took the greatest interest in these races, the same interest as to day in a sporting event. Passions ran so high that certain of the leading writers on railway matters, whose sympathies were with one or the other of the competitors wrote appreciations — and even gave information — that was inaccurate. These sensational races are so often quoted that we go, hereafter, into some details concerning them.

In the same way, for many years the *Pennsylvania R. R.* and the *Reading Company* (U. S. A.) maintained for publicity reasons the then remarkable speed of their rival expresses between Camden and Atlantic City. For runs of respectively 96 and 89.3 km. (59.7 and 55.5 miles), they only took 58 and 57 minutes, therefore maintaining an average speed of 99.3 and 94.2 km. (61.7 and 58.5 miles) an hour and often curtailing these remarkable timings.

It is also for advertising purposes that certain express trains or those running long distances are given names, when the trains have gained sufficient fame to appeal to the general public.

The oldest of them is, of course, the « Flying Scotsman » from London to Edinburgh, *East Coast,* which for the last 70 years has left King's Cross at 10 a.m. every day of the year, except Sundays. The popularity of this train will be appreciated by the fact that the Company had the happy thought of issuing a pamphlet which, at the cost of one shilling (thus not distributed free) has already passed through several successive editions.

The most celebrated train of the *New York Central Lines* is the « XXth Century Ltd. », the only one for which a supplement is still charged, and in spite of this, it usually runs in from two to seven parts. As a matter of fact, since September 1929, five trains in one direction and four in the other do the run of 1544.9 km. (960 miles) from New York to Chicago in 20 hours, that is at the rate of 77.2 km. (48 miles) an hour.

The 50th anniversary of the « Pennsylvania Ltd. », which had covered the 1461.3 km. (908 miles) from New York to Chicago daily since 1881, occurred on November 19th, 1931. This was the first long-distance « de luxe » train, and its original timing of 26 h. 35 m. has gradually been reduced by 8 h. 50 m. In 50 years this train alone has conveyed more than 6 1/2 million passengers.

The 1931 accelerations timed the « Congressional » (46th year), from New York to Washington, in 4 1/4 hours for the 365 km. (227 miles) or at 86.1 km. (53.5

(1) The distance from London to Aberdeen was at the time 523 1/2 miles by the East Coat line and 539 4/5 miles by the West Coast route.

miles) an hour, including the stoppages and slowing down near New York.

The « Liberty Ltd. » (New York to Chicago) saved 45 minutes and was timed to run in 18 hours.

For further information, we refer our readers to the second part of this article, which deals with railway runs in different countries.

Special trains. — In addition to the regular timings, specials have frequently made remarkable runs. These should be noted and their running analysed, as the exceptional journey of to day is an indication as to what can be done, and what may become the ordinary working of tomorrow. It therefore makes it possible to appreciate the margin existing between normal and possible services. For this reason, we quote a few instances.

The Great Western Railway (Gt. Bn). — On May 7th, 1903, the 4-4-0 locomotive « City of Bath » ran from Plymouth to London (Paddington) with a 250-ton train in 233 1/2 minutes, i. e. at an inclusive speed of 101.9 km. (63.3 miles) an hour.

This record was beaten on May 7th, 1904, during a race with the American mail. The 397.1 km. (246 3/4 miles) were covered in 226 3/4 minutes, in spite of a 3 3/4-minute stop at Bristol to drop the mail for the North of England and to change the locomotive. The average speed was 105.3 km. (65.4 miles) an hour.

The second part of this same journey was even more sensational. The 206 km. (128 miles) from Bristol to London via Bath were covered in 120 minutes. The train was drawn by the 4-4-0 locomotive « City of Truro », which is preserved in the railway museum at York and which reached a maximum speed of 164.6 km. (102.3 miles) down Wellington Bank. This is the highest speed that has ever been reached in England.

On May 9th, 1909, the same train carrying the American mails from Plymouth (*North Road*) for London was hauled from Bristol to Paddington (190.7 km.= 118 1/2 miles) via Bath in 99 minutes 46 seconds, i.e. at the speed of 114.8 km. (71.3 miles). The average speed from Swindon was over 128.7 km. (80 miles) an hour and the maximum 147.7 km. (91.8 miles) near Slough.

The 2-2-2 locomotive « Duke of Connaught » maintained an average speed of 125.5 km. (78 miles) an hour between Wootton Basset and Westbourne Park, the 131.6 km. (81 3/4 miles) being covered in 62 minutes 55 seconds.

Finally in 1923, the 2.30 p. m. express from Cheltenham to London, consisting of 9 carriages weighing 230 tons, hauled by the 4-6-0 locomotive « St. Bartholomew », covered the 124.4 km. (77.3 miles) from Swindon to Paddington in 72 minutes, i.e. at the average speed of 103.8 km. (64 1/2 miles), and a maximum one of 133.6 km. (83 miles) an hour.

These various runs were the prelude to the extraordinary running of the present « Cheltenham Spa Flyer ».

In France, the *Paris-Orleans Railway*, in April 1930, and in March 1931, carried out a series of speed and consumption tests with a 4-cylinder compound locomotive with high superheat and poppet valve gear. On March 27th, 1931, it hauled the « Sud Express », weighing 450 t. (443 Engl. tons) over the 584 km. (363 miles) from Paris (Austerlitz) to Bordeaux (St-Jean), in 5 h. 50 m., i. e. at the inclusive speed of 100 km. (62 miles) an hour, and at the running speed, stops and speed restrictions excluded, of 109.5 km. (68 miles) an hour.

The special train No. 10339 of March

12th, 1932, was booked at the running speed of 110 km. (68.3 miles) an hour, between Les Aubrais and Redon. It reached a maximum speed of 126 km. (78.3 miles) an hour [1].

These trials showed that it was possible to accelerate even the fast trains and as soon as the Paris-Orleans Railway had taken delivery of suitable locomotives, it reduced the running times of a number of its main line expresses [2]. This is why trials of this kind should be so closely followed.

In the United States, EXCEPTIONAL RUNS are especially noteworthy by the long distances they cover.

New York Central Lines. — On May 10th, 1893, an experimental run was made (from New York to Chicago (1539 km. = 956 miles) with the « Empire State Express » consisting of 4 carriages weighing 161 1/2 tons, hauled by a 4-4-0 locomotive (No. 999). The 111 km. (69 miles) from Rochester to Buffalo were covered in 68 minutes, i.e. at an average speed of 98 km. (60.9 miles) an hour, an extraordinary performance at the time. It is claimed that one mile between Rochester and Buffalo was covered in 32 seconds, i.e. at the rate of 181 km. (112 1/2 miles) an hour. It is possible, of course, but....

Pennsylvania Lines. — To mention more recent examples, the special run of the train which carried Lindbergh's reception films to New York is noteworthy. It covered the 361.3 km. (224 1/2 miles) from Washington in 187 minutes, i.e. at the speed of 115.8 km. (72 miles) an hour, or 120.5 km. (74.9 miles) an hour, stops being deducted.

The 347.9 km. (216 miles) from Washington ta Manhattan Transfer where, in 3 minutes, an electric locomotive was substituted for the steam one, was, in spite of a 4-minute stop to take water, covered in 175 minutes, i.e. at 119 km. (74 miles) an hour, and 121.8 km. (75.78 miles) per hour, running speed.

The highest speed was reached between Helmesburg Junction (near Philadelphia) and South Street, Newark, these 107.2 km. (66.6 miles) being covered in 47 minutes, i. e. at 136.8 km. (85 miles) per hour.

CHAPTER II.

Generalities relating to speeds.

II-1. — **Safety and speed.** — We now come to speed itself — influenced not only by all the causes we have quoted, but also by many others. In a recent address, Sir Felix Pole said that the railway was the only means of transport that could be used, in all weathers, at all speeds, and that with almost perfect safety and punctuality.

The immense difference that exists between rail and road traffic is not sufficiently grasped. This is due in part to the publicity that is always given to the smallest railway accident, in spite of the fact, that, during certain years, no fatal accidents have occurred to any of the

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(1) Locomotive 3701 (formerly 3566); weight of train 435 t. (428 Engl. tons).

Train No. 7 of June 28th, 1932, was hauled on the 214 km. (133 miles) from St-Pierre-des-Corps to Angoulême at the average speed of 107.1 km. (66.5 miles) an hour [nominal speed: 110 km. (68.3 miles) an hour]. It weighed 546 t. (537 Engl. tons) (locomotive 3705).

Finally, train No. 4 of June 29th, 1932, covered the return journey at the nominal speed of 90 km. (56 miles) hour, with a load of 752 t. (739 Engl. tons).

(2) Cf. the examples quoted in the second part of this article.

many millions of passengers who have travelled by rail in large countries such as France or England. It often happens that motor cars kill as many people in a single day as do the railways in a whole year. And this is not sufficiently emphasised.

If unfortunately two successive railway accidents do occur, even insignificant ones, there is immediately a press campaign, followed by questions in Parliament.

There are no statistics showing that out of so many passengers carried by road or by rail the proportion killed by the former is so many times higher than by the latter. Figures exist, however, which give some idea of the relationship. These have been kindly supplied to us by the « National Safety First Association ».

TABLE 2.

NUMBER OF PERSONS KILLED OR INJURED ON THE RAILWAYS.

YEAR.	CLASS OF PERSON.	Total accidents to all classes.		Number of passengers carried.	Number of train miles (train-km.) passenger & goods.
		Killed.	Injured.		
				(In millions.)	(In millions.)
1929	Passengers.	76	4 210		
	Staff	219	3 267		
	Others	63	165	1 705	427.4 (687.8)
	Totals :	358	7 642		
1930	Passengers.	66	4 216		
	Staff	208	2 977		
	Others	55	149	1 685	424.2 (682.7)
	Totals :	329	7 342		
1931	Passengers.	71	4 111		
	Staff	159	2 714		
	Others	59	161	1 606.2	411.7 (662.6)
	Totals :	289	6 986		

This table shows that every 5 people killed, comprise in round figures, one passenger, three employees, and one other such as a trespasser or a suicide. The number of persons injured includes people who hurt themselves colliding with some part of the permanent way equipment.

From 1920 to 1924 the number of fatal casualties was on the average 407, and 368 from 1925 to 1929. It still fell to 329 in 1930 and to 289 in 1931.

This shows that, in 1931, there was one passenger killed per 200 million passengers carried, and one injured per 4 millions, to which should be added one em-

TABLE 3.

NUMBER OF PERSONS KILLED OR INJURED PER ONE MILLION TRAIN MILES
(per 1 million train-km.).

YEAR.	Train-miles. (*train-km.*)	Average number killed.	Average number injured.
	(In millions.)		
1920/24	1 848 (2 974)	1.1	17
1925/29	1 661 (2 673)	0.9	18
En 1930	1 685 (2 712)	0.8	17
En 1931	1 606 (2 585)	0.7	17

ployee killed per 52 million train-km. (per 32 million train-miles).

There were on an average 14 passengers killed and 521 injured in Great Britain between 1921 and 1930 inclusive ; there were in addition 208 employees killed and 2 960 injured. From 1921 to 1931 the number killed fell by 22.6 %.

In hardly any case has the speed of the train caused accidents. They are sometimes attributable to the mechanical side, but more usually to the human element. The railways — in France particularly — have arrived at such perfection in controlling the latter, that mistakes are becoming more and more exceptional, no matter the speed upon which the timetable is based.

TABLE 4.

NUMBER OF PERSONS KILLED
BY ROAD MOTOR CARS.

YEAR.	Killed.	Injured.	Total.	Number of vehicles.
1928 . .	5 378	126 975	132 353	2 012 904
1929 . .	5 906	134 050	139 956	2 149 228
1930 . .	6 444	140 072	146 616	2 237 474
1931 . .	5 817	158 888	164 705	2 176 620

Table 4 is compiled from information supplied by the Home Office and the Ministry of Transport.

There are no statistics available concerning the number of passengers carried nor the mileage run. But the « estimated » figures issued by the Society of Motor Manufacturers and Traders for the year 1931 may throw some light on the subject.

TABLE 5.

TYPE OF VEHICLE.	Number of passengers killed per 10 million miles (*per 10 000 000 km.*) run.
Motor buses and cars . . .	4.8 (*3.0*)
Tramways.	3.0 (*1.9*)
Motorcycles	4.3 (*2.7*)
Automobiles.	2.4 (*1.5*)
Taxies	1.1 (*0.7*)
Motor lorries and tractors .	2.4 (*1.5*)
Average :	2.9 (*1.8*)

The data also show that there were 102 road accidents resulting in the death of 106 persons during the single week ending August 28th, 1931.

During the year 1921, 2 660 persons were killed in 57 481 road accidents, and

in 1931, 6 031 in 165 112 accidents. The percentage killed had increased during the same period from 7 to 16 per 100 000 inhabitants, which is very alarming. In other words, road transport kills in *one* year 50 % more people than the railways, in spite of their much greater traffic, have killed in *ten* years, and whereas on the railways, there was a reduction of 22.6 % in ten years, motor road transport showed an increase of 127 %.

To complete this review, we quote data relating to air and sea transport.

TABLE 6.

ACCIDENTS TO COMMERCIAL AIRCRAFT IN REGULAR SERVICES.

(Communicated by the *Air Ministry*.)

YEAR.	Killed.	Injured.	Miles (km.) flown.	Passengers carried.
1929 . .	12	1	1 189 240 (1 913 860)	28 260
1930 . .	3	1	1 222 000 (1 966 580)	23 440
1931 . .	0	0	1 354 000 (2 179 000)	23 480

TABLE 7.

ACCIDENTS AT SEA TO BRITISH SHIPS (EXCLUDING WARSHIPS).

(Figures communicated by the *Board of Trade*).

YEAR.	Crew.			Passengers.			Total.
	Due to ship accidents.	Due to persons only.	Total.	Due to ship accidents.	Due to persons only.	Total.	
1928	190	302	492	72	41	113	605
1929	137	331	468	10	37	47	515
1930	31	308	339	6	68	74	413
Total. . .	358	941	1 299	88	146	234	1 533

II-2. — **Speed between two localities.** — After all, the speed of the fastest trains between two localities, is only an indication, for though it actually takes place, it is misleading in considering the rapidity of communication between the two places.

Whereas there may be a series of hourly fast trains, as those from London to Brighton for instance, there may also be but a single fast train, all others being scheduled at a lower speed.

It is therefore necessary to note the *inclusive speed of all the express trains*, and to consider the ratio of their average speed to the speed of the fastest train. This ratio should tend towards the unity and in these last years, on a number of lines, this has been the case.

It is not necessary to deduct the time spent stopping, as it is of little interest to the passenger between extreme stations of the line whether the time is spent stopping or running. Obviously only trains that stop frequently should be considered if a passenger between extreme stations would use them.

If we consider the *inclusive speed of all the trains of a given line*, we arrive at an

index which is necessarily lower, but which also tends to increase.

In a previous article dealing with train speed and main traffic currents, of July 1914 (which appeared in the *Railway Gazette*), we compiled these indices for the Brussels and Antwerp line. The following were the results :

TABLE 8.

INDICES OF THE SPEEDS OF THE BRUSSELS AND ANTWERP LINE.

—	One direction only.	Both directions.
Fastest journey . . . . minutes.	34	...
Inclusive speed. . . . . km. (*miles*) p. h.	77.6 (*48.2*)	...
Inclusive speed of all Brussels-Antwerp trains (different terminal stations at the two towns) . . . . . km. (*miles*) p. h.	62.6 (*38.9*)	61.4 (*38.15*)
Inclusive speed of all the trains of the line . km. (*miles*) p. h.	47.7 (*29.64*)	47.6 (*29.57*)
Ratio $\frac{\text{Inclusive speed of all the trains}}{\text{Maximum inclusive speed}}$	0.807	0.791
Ratio $\frac{\text{Inclusive speed of all trains of the line}}{\text{Maximum inclusive speed}}$	0.614	0.600

II-3. — **Speed margins.** — Whereas certain companies time their trains at a speed approaching the maximum capacity of their locomotives, others leave a sufficient margin to enable them to make up lost time or to haul unusual loads. This latter system is becoming more general, owing to the importance of punctuality. Premiums for regularity, in use in many countries, are combined with fuel economy premiums and safety measures.

Making up lost time has few drawbacks in countries such as France, where speedometers and other recording instruments effectively control whether speed restrictions have been properly observed and how the staff's reflexes have reacted to the signals indications.

In the United States this question is of particular importance owing to the fact that legislation only allows supplementary charges on « de luxe » and express trains on condition the Company shall refund either a certain percentage or a given sum for each hour the train is late. The staff are made to understand that it is important to regain lost time and are punished if they have caused it. It is for the same reason, and unlike European practice, that the last stage of a journey, when approaching great cities such as New York, is timed at a lower speed than the others ; this acts as an equaliser, making it possible to catch up a certain amount of lost time.

II-4. — **Different speeds.** — Few elements have a greater and more immediate effect on operating efficiency than the speed of the trains, as the capacity of the lines depends on them and is greater when the trains have similar speeds. When speeding up, it is therefore desirable that this should affect all classes of trains.

For this same reason, when it is possible to do so, it is as well to group the trains of the same type, on double and quadruple as well as or single track lines (1).

On the *Paris-Lyons & Mediterranean Railway*, for instance, the main line has probably what is the longest of common sections, since it extends from Paris to Dijon 315 km. (196 miles), where the main lines to Vintimiglia, Belfort, Vallorbe, Geneva and Modane all branch off. It is also one of the most heavily loaded sections since between 6.30 and 11 p. m., 18 fast trains leave Paris for Dijon and beyond. They are normally run at ten-minute intervals, but on days of heavy traffic (before holidays, etc.) as many as 30 expresses leave Paris at 5 to 6-minute intervals.

On the *London & North Eastern Railway*, to quote another example, the mid-day expresses arrive in London at quarter of an hour intervals. This also makes it possible, if necessary, to duplicate them.

The maintenance over long stretches of the same running speed, however high it may be, is one of the fine qualities of the present-day locomotive. It is particularly desirable, therefore, to reach this speed quickly and from this point of view the French and English locomotives are admirably responsive.

In Belgium, the locomotive which brought the train into certain termini is uncoupled and is used as a pusher in starting it. This has also the advantage of running one outward train only for clearing the track both of the train and of the locomotive that brought it in.

II-5. — **Effect of the layout on speed.** — Many factors affect the speed : longitudinal gradient section of the line, intermediate stops, obligatory speed restrictions, type and power of the locomotive, weight of the train, etc., and these necessarily prevent any proper comparison from which to draw conclusions regarding the technical efficiency of a given railway or line, but they do not prevent examining train speeds as we do here.

A series of these factors would implicitely be taken care of were we to consider virtual speed, and would be acceptable were we comparing the speeds for the purpose of drawing conclusions concerning the locomotives or the layout only, as this would indicate the virtual percentage of elongation for a given line. Virtual distances are valuable because they enable one to draw graphic timetables easily and facilitate the apportionment of coal. But they would not do here any more than the Swiss tariff-kilometre, save in special cases.

As a rule, only the fastest speed of the

(1) If, for example, crossing stations on a single-track line, are, say 20 km. apart (as is the case in Russia or the Argentine) the 40 km. there and back must be covered before a second train is run in the same direction. By simply installing intermediate telephone booths, say every 4 km., it is possible to run 5 trains in one direction, then 5 in the other (provided there are 5 sidings in each of the two stations). The fifth train starting the moment the first arrives, all the trains will therefore arrive at their destination in the two directions in the time that is otherwise required for running twice 20 km. in each direction, i. e. 80 km. If the trains were sent alternatively at the same interval in each direction, it would only have been possible to send two of them in each direction, that is four instead of ten. This system was used on the *Rio Grande do Sul Railway* during periods of heavy cattle traffic; it was also the system that was *not* used in Russia before the Carpathian debacle.

fastest train between two given localities is considered. This is evidently useful, but it is not sufficient to appreciate the speed of the trains between these two points.

When the speed it too low, explanations are always given. For instance, it is contended that it is not higher because of the gradients or because of speed restrictions caused by single-line tunnels, swingbridges, crooked lines in the stations, small-radius curves. Although this be true, it has nothing to do with the question. We might as well say that the speed is not higher because the locomotive is too old.

If the curve is of too small radius, open it out. Double the single-track tunnel, or eliminate the swingbridges. For it should not be forgotten that the speed results from collaboration between the traction and permanent way departments and not from the locomotive only. It was, moreover, by acting in this way that the French State Railways were able to increase their speed recently and to bring their services to the fore.

Speed restrictions which are implicitly taken into account in the virtual length of a line, are most prejudicial because they involve the destruction of energy. Consequently, in many cases a simple calculation of the coal saved by eliminating them makes it possible to cover, sometimes even with profit, the financial charges required to suppress them.

It is on this basis that the *Great Western Railway* undertook the construction of express train lines avoiding Westbury and Frome, even though it was only possible to save 3 minutes, and that the *London & North Eastern Railway* undertook similar work at Peterborough.

The same situation exists on the French Eastern Railway at Epernay and at Châlons-sur-Marne and at various points on the *Paris-Lyons & Mediterranean Railway* main line. Another classic example is that of the single-track tunnel of Braine-le-Comte, on the main Paris and Brussels line, where a second single track line has recently been built over the tunnel. It would be interesting to have figures showing whether the economies due to the coal savings, to the suppression of the speed restrictions (or stops) and to the suppression of piloting have compensated the financial cost of building the second line.

A further class of speed restrictions is due to the presence of old swingbridges which sometimes make it necessary to reduce the speed to 20 km. (12 miles) an hour. This hampers the traffic by unduly extending the runs ; it causes the line to be occupied too long and, at times, considerably diminishes its capacity. New swingbridges are now crossed at speeds reaching 80 km. (50 miles) an hour (Belgium) and 100 km. (62 miles) at Abbeville (Nord). But this Company has not yet doubled its single track through the Huy tunnel on the main Paris, Namur, Liége and Germany line.

II-6. — **Decelerations.** — Although speed increases pretty continuously, retrogressions happen — seldom, it is true — which are due to various causes.

A pretty general reduction of speed followed the Preston accident (*L. & N. W. Ry.*) and the same happened in France after the Sud Express smash (*Midi*). Not that high speed is dangerous in itself but the most insignificant railway accident has always such an effect on the general public that drastic steps must immediately be taken to soothe their feelings.

It is well known that, until a short time back, few expresses had recuperated

their pre-war speed. This was due in part to constant increase in weight. But apart from this, local causes are responsible for some decelerations. Thus, in 1931, the Midi Railway had to slow down in accordance with instructions from the higher authorities, and during the second half of the same year 14 minutes had to be added to the fast runs between Milan and Venice, which had been timed too high.

CHAPTER III.

Geographical distibution of the speeds.

Owing to the reliability of the modern locomotive, each railway has at least one section of line on which high speeds are possible. When such sections are long, they imply that the line and the track have kept pace with the progress of the locomotive. Such lines must present no obstacles to speed or, if such exist, they should be removed.

As a rule, high speeds are to be found in certain areas only, either because the others are inappropriate or because the Company's system does not extend beyond. Recently, however, inter-railway arrangements have done away with many of these artificial frontiers and the locomotive and train staff of one Company frequently operate into another's territory, sometimes for a considerable distance.

Such is the case of the non-stop trains between Paris and Brussels, of those running from Paris to Liége (French Northern Ry.) and of the French Lille and Calais section worked by Belgian locomotives. In England, the Berwick and Edinburgh sections of the N. B. Ry. was for many years worked by *North Eastern* locomotives drawing non-stop Newcastle and Edinburgh expresses.

The French State and the Paris-Orleans Railways have also just come to an interesting arrangement concerning the working of the Paris rapides and the latter's long line extending from Tours to Angers, Nantes, Redon and Quimper in the State Rys. area. From May 15th, the Paris to Redon rapides follow the State Rys. line and only run onto the Paris-Orleans beyond Redon.

III-1. — **Geographical distribution of express services.** — These generally form two groups of unequal importance.

The first includes the services radiating from the centre of the system — often the capital of the country — and the more the country is centralised, as in France, the more important are these services.

If the country has secondary important centres, as in England and in Germany, these should be considered in turn, and if they be of similar importance as were the two capitals of the former Austro-Hungarian Empire, the main line services show a very particular character.

The second group comprises cross country and inter-railway services which have been developed recently. Previously, in countries such as France and even in Belgium, it was usually easier and quicker when travelling between two large provincial cities to do so via Paris or Brussels respectively. This is not so today; consequently it is necessary to look into cross country services now to be found on the Continent as well as in England.

Such services have always existed in Germany and Holland where the secondary large centres are numerous, but they have distinguishing features : the trains are usually made up of carriages coming from all directions and going to a num-

ber of different points. The stops are therefore longer, as constant shunting takes place.

On the other hand, in France and Belgium, the passenger and not the carriage has to change trains.

The establishment of interprovincial trains is more difficult than that of radiating ones from the main centre. For the primary or secondary centre always draws traffic from the periphery, whereas it is never easy to decide if a cross country service may be directly or indirectly remunerative.

It is nevertheless to this class of train that the two most interesting French cross country services belong : the « Manche-Océan » (from Dieppe to Rouen, Nantes, La Rochelle and Bordeaux), started in 1929, and the « Côte d'Emeraude - Pyrénées » (from Saint-Malo to Bordeaux and Hendaye), which dates from 1930.

Likewise in Spain, there is a through express from Barcelona to Valencia, Cordoba and Sevilla, connecting the North East with the South East of the country.

Finally, there is a class of mixed lines which is an unimportant cross-country one, if only considering the Company to which it belongs, but which may be a highly important one as a link in a larger chain of through traffic. Such are lines which cross an intermediate railway connecting two outside centres. For the intermediate railway, this is simply a cross country line, whereas for the foreign centres, it is a radiating one.

The London-Basle-Milan service is an instance. Its Boulogne (or Calais)-Laon-Belfort section of the *North* and *Est* Railways is just one of these Companies' cross country services on which the highest speed of such services is to be found, precisely because it eventually connects such places as London with Milan and beyond.

Such is also the case of the *Nord* section (Calais to Baisieux) of the London, Calais and Brussels line and of the Belgian Erquelinnes and Liége section of the Paris and Berlin through services.

The cutting up of Central Europe has multiplied sections of the kind, as exchanges subsist between places now separated by strips of other countries. Such is the case for the German services when crossing the Polish Corridor, or further South, for the Bavarian trains running into Italy across the Tyrol and for the « Orient-Express » passing through Czechoslovakia when travelling from Vienna to Budapest.

International express trains giving these cross-country services are similar to radiating ones but differ from them in that they are timed according to the needs of the regions they serve.

III-2. — **International competition.** — In spite of internal competition being done away with by grouping the whole or portion of a country's lines, international or inter-railway competition survives and a transfer of traffic from one Company to another frequently changes international traffic as well.

Through western continental traffic follows well defined channels, i. e. :

a) Anglo-Italian connexions through France, using rival routes between London and Paris, and also for the Franco-Italian traffic (fig. 1);

b) Anglo-German and Anglo-Belgian traffic through France, Belgium and Holland (figs. 2 and 3);

c) Dutch-Swiss traffic through Belgium and Alsace-Lorraine or through Germany (fig. 5);

d) Franco-Austrian communications and their extensions to Rumania and Turkey (fig. 6).

PARIS TO MILAN SERVICES.

The line from Paris to Milan by the *Paris-Lyons & Mediterranean Railway*, the Mount-Cenis tunnel and Turin was opened to traffic in 1871.

That from Paris (*Est*), through Belfort, Basle and the Saint-Gothard tunnel, in 1882.

That from Paris to Milan, by the Simplon tunnel, in 1906.

Fig. 1. — Competing routes from London and Paris to Milan and Rome.

Finally its complement, through the Lötschberg tunnel, at the end of 1913. In addition, the construction of the Grenchenberg tunnel through the Jura in 1916, provided a new line 806 km. (500 miles) long, from Paris (*Est*) to Milan, i. e. 47 km. (29 miles) longer than the Simplon route (P.-L.-M.), but 80 km. (50 miles) shorter than the St-Gothard one.

Rakes from Paris by the Simplon and from Paris (*Est*) by the Lötschberg meet

at Brig. The latter are simply detached at Belfort, from the *Est* trains going to Basle.

We have quoted present timings. But during the summer of 1931, the Paris (*Est*), Basle and Gothard Express to Milan was the fastest service although using the longest route.

TABLE 9.

PARIS-MILAN SERVICES (fig. 1).

ROUTE.	Time of departure.	Time spent.	Distance		Speed	
			Km.	Miles.	Km./h.	Miles/h.
Paris (P.-L.-M.)-Mt-Cenis-Milan .	9.35 p. m.	16 h. 35	924	574	55.7	34.6
Paris (P.-L.-M.)-Simplon-Milan .	8.10 p. m.	14 h. 05	836	520	59.3	36.9
Paris (Est)-Basle-Gothard-Milan .	12.35 noon	14 h. 07 (1)	898	558	63.6	39.5
Paris (Est)-Lötschberg-Milan . .	7.10 a. m.	14 h. 40 (2)	870	541	59.3	36.9

PARIS-ROME SERVICES.

The new Bologna and Florence line will shorten, by an hour, the journey from Paris to Rome in favour of the St. Gothard and to the detriment of the Mount-Cenis routes. The *Est* will thus be able to divert this traffic over its own metals. But as a means of defence, the *P.-L.-M.* and Swiss railways came to an understanding in 1932, whereby the « Rome-Express » (3) would be run via the Simplon instead of the Mount-Cenis, thus still remaining — though for a lesser time — on the *P.-L.-M.* system. But so far, this scheme has not matured. The Turin-Genoa line would then be given up to the profit of Switzerland.

The French *Est* replied on May 22nd, 1932, by still further speeding up the Calais-Basle train which, during the night, covers the 772 km. (480 miles) in 9 h. 18 m., that is at an inclusive speed of 83.1 km. (51.6 miles) an hour. This brought London within 30 h. 50 m. from Rome (4) and the « Gothard Express », having no longer any object, was suppressed.

The speeding up of the *Est* services has had some curious repercussions. Thus Zermatt, which previously had depended on the Vallorbe-Lausanne-Simplon services, is now more easily reached from Paris (*Est*) via Delle, Berne, the Lötschberg, Brig and Visp. Although 64 km. (40 miles) longer from Calais

(1) The Gothard Pullman train is discontinued.

(2) This is the present-day service since the withdrawal of the « Gothard Pullman express » service in 1931. It had 16 intermediate stops in the course of its Belfort and Brig (259 km. = 161 miles) run which took 5 3/4 hours. In spite of this, the Est and Lötschberg route was 35 minutes quicker, on the outer, and 53 minutes, on the return journey. It should be possible to gain an hour on existing schedules were it to run at the same speeds as the French *Est Ry*.

(3) Leaving Paris at 8.50 p. m. in Summer (8.10 p. m. in Winter), it was to arrive in Rome at 8.40 p. m.

(4) Leaves London at 4 p. m.; arrives in Rome at 11.50 p. m. the next day.

(via Laon), the line is a quicker one and is more picturesque, running as it does, through the Bernese Oberland.

TABLE 10.

LONDON AND CALAIS TO MILAN AND ROME.

a) CALAIS AND MILAN SERVICES.

ROUTE.	Distance	
	Km.	Miles.
Calais-Laon-Delle-Lötschberg-Milan	1 067	665
Calais-Laon-Basle-St. Gothard-Milan	1 148	713
Calais-Paris (P.-L.-M.)-Simplon-Milan	1 075	668

On French territory, the *P. L. M. Ry.* only is concerned in the third of these lines, the *Est*, with the two first, thus competing for the international traffic. In Switzerland, the interests of the *Federal Rys.* vary according to the route. This is 322 km. (200 miles) long by the St. Gothard, 214 km. (133 miles), by the Simplon-Vallorbe, and 173 km. (105.7 miles), by the Lötschberg route. All three use the *Federal Rys.* lines save for 64 miles from Thoune to Brig of the latter route, which run over the *Lötschberg-Simplon Ry.* and its allied companies. The preferences of the *Swiss Federal Rys.* therefore go to the St. Gothard route. As far as Italy is concerned, the choice of route is indifferent.

Although over the longest and most difficult one, involving as it does two crossings of the Alps and Appennines, the run from Calais to Milan, Genoa and Rome, via the St. Gothard, is accomplished at an overall speed of 65.5 km. (40.7 miles) per hour, or 73.2 km. (45.5 miles) running time, after deducting 2 3/4 hours for stops. This is due to the excellent services of the *Nord* and the *Est*, who book their runs at an inclusive speed of 87 km. (54 miles) an hour for the 700 km. (435 miles) from Calais to Belfort [1].

In 1933 the « Rome Express » was put on again but it is an accelerated « Rome Express » (particularly in Italy), which brought the advantage back to this route, for it took but 22 h. 40 m. from London to Rome, as against 25 h. 5 m. by the St. Gothard.

TABLE 11.

b) CALAIS AND PARIS AND ROME SERVICES. (fig. 1).

ROUTE.	Calais-Rome		Paris-Rome	
	Km.	Miles.	Km.	Miles.
By Laon, Basle and the St. Gothard. . . .	1 769	1 099	1 564	972
By the P. L. M. Railway and Mount-Cenis	1 762	1 082	1 447	899
By the P. L. M. and the Simplon.	1 793	1 114	1 487	924

(1) The fastest train from Belfort to Calais (4.53 a. m.) actually takes 8 h. 32 min. to cover the distance, i. e. at the average speed of 82.1 km. (51 miles) an hour.

As the distance from London to Calais (or Boulogne) is the same by the three routes, we have only stated distances from the French ports [1].

TABLE 12.

ANGLO-FRENCH PARIS AND LONDON SERVICES.

SEA ROUTE.			Time of departure.	Time spent.	Distance in		Speed	
Km.	Statute miles.	between			Km.	Miles.	Km./h.	Miles/h.
42	26	Calais and Dover.	R 11.00 a. m.	6.40	469	291.4	70.4	26.7
51.9	32	Boulogne and Folkestone . .	4.40 p. m.	6.25	425	264.1	75.1	46.6
81.5	51	Dunkirk and Folkestone . .	R 11.0 p. m.	11.00	515	320	46.8	29
118.5	74	Dieppe and Newhaven . . .	R 10.05 a. m.	7.47	378	234.9	48.5	30.1
194.8	120	Havre and Southampton . .	7.55 p. m.	13.08	552	343	42.0	26

TABLE 13.

ANGLO-BELGIAN SERVICES — LONDON TO BRUSSELS.

ROUTE : BRUSSELS TO LONDON BY	Km. (*Statute miles.*)	Time of departure.	Time spent.	Distance		Speed	
				Km.	Miles.	Km./h.	Miles/h.
Antwerp and Harwich . .	250 (155)	R 8.30 p. m.	12 h. 59	409	254.2	31.5	19.6
Zeebrugge and Harwich .	148 (92)	9.13 p. m.	10 h. 47	369	229.3	34.2	21.2
Ostend and Dover . . .	111 (69)	11.0 a. m.	6 h. 58	356	221.2	51.1	31.7
Dunkirk and Folkestone .	82 (51)	8.46 p. m.	10 h. 54	398	247.3	36.5	22.7
Calais and Dover (Winter).	42 (26.1)	9.3 a. m.	6 h. 33	389	241.7	60.6	37.7
Boulogne and Folkestone .	52 (32.3)	2 p. m.	6 h. 59	432	268.4	61.9	38.4

Competition between the capitals is not only a question of speed of the several rail and air routes, but also a matter of fares and of comfort, particularly for night journeys.

As from October 2nd, 1932, the number of services was reduced, but others were speeded up. Thus a stop at Boulogne has been inserted in the 8.25 a. m. run from Paris to Calais, without delaying its arrival in Calais and passengers by the 4.40 p. m. train from Paris get into London in 6 h. 25 m., though the

(1) As regards Paris-Genoa, the following are the comparative distances :

By the St. Gothard, 1 257 km. (781 miles);
By the Simplon, 1 281 km. (796 miles);
By Mount Cenis, 1 250 km. (777 miles).

15 h. 18 m. are required from Genoa to Paris by Mount-Cenis (Paris-Rome Express) and 17 h. 30 min. from Paris to Genoa by the Simplon-Orient.

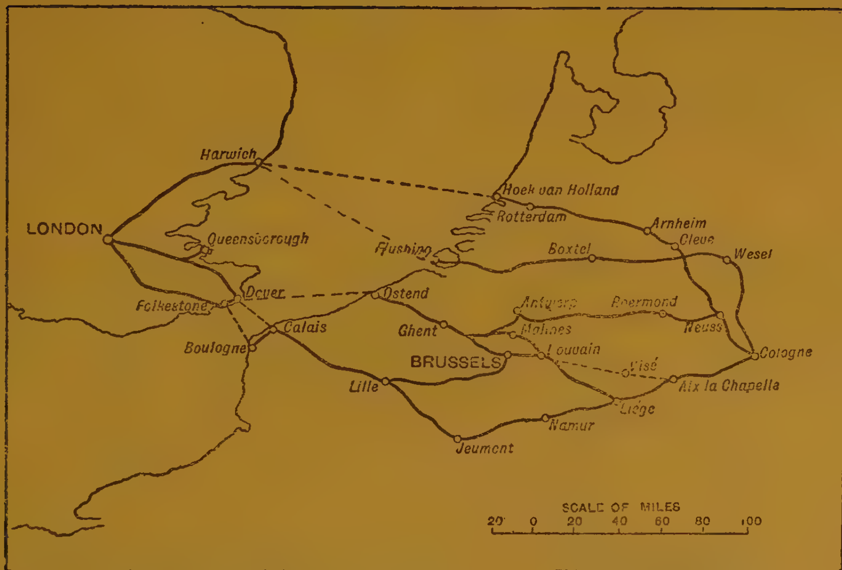


Fig. 2 (1). — Competing services from London to Cologne through France, Belgium and Holland.

Fig. 3. — Competing services from London to Berlin, through France, Belgium and Holland.

train stops at Etaples on the way (2). This is the fastest time ever achieved between Paris and London, as also from Strasbourg (leaving at 12.57 a.m.) and

(1) This illustration, and also figures 3 and 4 originally appeared in *The Railway Gazette* in 1915, when a previous serial dealing with Train Speeds in August 1914, appeared.

(2) Distance from Paris to Etaples, 226.1 km. or 140 miles. As the train takes 132 minutes to cover it, the average speed is 102.8 km. or 63.9 miles.

from Nancy (leaving at 11 a. m.) which give quick connections.

Although there are about half a dozen different routes, competition, as regards speed, is reduced to that between the Ostend-London and the Calais (or Boulogne) ones.

The distance from Victoria to Dover is 128.7 km. (80 miles) by the line taken by the Continental expresses and 123.9 km. (77 miles) from Charing Cross.

TABLE 14.

ANGLO-GERMAN SERVICES. — *a*) LONDON TO COLOGNE (fig. 2).

SEA PASSAGE.		ROUTE.	Time of departure.	Time spent.	Distance		Speed	
Km.	Statute miles.				Km.	Miles.	Km./h.	Miles/h.
52	32	Folkestone-Boulogne . .	2.0 p. m.	11 h. 44	648	402.7	55.2	34.3
42	26	Dover-Calais	R 4.42 a. m.	10 h. 48	605	375.9	56.0	34.8
Do.	Do.	*Dover-Calais (Jeumont)* .	9.00 a. m.	*12 h. 00*	*632*	*393*	*52.8*	*32.8*
111	69	Dover-Ostend (Pullman) .	R 10.40 a. m.	10 h. 46	511	317.5	47.4	29.4
200	124 3	Harwich-Hook of Holland.	8.30 p. m.	13 h. 58	615	382.1	44	27.3
187	116.3	Harwich-Flushing. . .	10 a. m.	12 h. 42	651	404.5	51.2	31.8

Before the War, the fastest train from Calais to Cologne, which is shown in italics, ran through Lille, Jeumont and Liége. Trains in this service now go through Brussels.

TABLE 15.

ANGLO-GERMAN SERVICES. — *b*) LONDON TO BERLIN (fig. 3).

SEA PASSAGE		ROUTE : London-Berlin, by	Time of departure.	Time spent.	Distance		Speed	
Km.	Statute miles.				Km.	Miles.	Km./h.	Miles/h.
52	32	Folkestone-Boulogne-Brussels and Berlin . . .	2.0 p. m.	18 h. 26	1 211	752.5	65.7	40.8
42	26	Dover-Calais-Brussels . .	9.36 p. m.	17 h. 54	1 179	732.6	64.5	40.1
Do.	Do.	*Dover-Calais-Jeumont* .	9 00 a. m.	*21 h. 05*	*1 218*	*757*	*58.1*	*36.1*
111	69	Dover-Ostend-Brussels. .	2.30 p. m.	17 h. 56	1 124	704.4	55 5	34.5
Do.	Do.	*Dover-Ostend-Malines* .	...	*20 h. 15*	*1 159*	*720*	*57.1*	*35.6*
200	124.3	Harwich-Hook of Holland-Berlin (Sch.). . . .	R 1.11 p. m.	19 h. 27	1 010	627.6	52	32.3
187	116.3	Harwich-Flushing-Berlin (Sch.).	9.30 a. m.	20 h. 45	963	598.4	46.4	28.8

We have shown in italics the information concerning obsolete pre-war services.

Fig. 4. — Competing London and Basle services through France, Belgium and Holland.

Fig. 5. — Competing services between Amsterdam and Basle via Brussels, Liége and Cologne.

Table 16.

FASTEST LONDON AND BASLE SERVICES (fig. 4).

ROUTE BY	Distance		Time of departure.	Time spent.	Speed	
	Km.	Miles.			Km./h.	Miles/h.
Folkestone-Boulogne and Paris *Nord* and *Est*	971	603				
Folkestone-Boulogne-Laon. . .	908	564	2.0 p.m.	13.30	67.2	41.7
Folkestone-Dunkirk	932	579	11.0 p.m.	17.48	46.2	28.7
Calais-Dover-Laon	953	592	R 3.35 a.m.	13.20	71.5	44.4
Ostend-Dover-Brussels	830	516	12.10 (night)	16.32	50.2	31.2

Table 17.

BEST AMSTERDAM AND BASLE SERVICES (fig. 5).

ROUTE FROM Amsterdam to Basle, by	Time of departure.	Time spent.	Distance		Speed.	
			Km.	Miles.	Km./h.	Miles/h.
Cologne, by the « Rheingold » .	7 52 a.m.	10 h. 16	781 (1)	485.3	76.1	47.3
Brussels by the « Edelweiss » .	9 20 a.m.	11 h. 14	795 (1)	494	70.3	45.4
Liége and Luxemburg	8.11 a.m.	12 h. 05	727	452	60.1	37 3

The two first are « de luxe » trains conveying 1st and 2nd class passengers; the third is a through express which, in Belgium, has the characteristics of a cross country one.

Services to Vienna and the near East.

Before the War there was but a single express line from Paris to Istanbul. This was the one taken by the « Orient Express » from Paris (*Est*) to Budapest beyond which it continued alternatively to Sofia-Constantinople or to Bucarest-Constantza, with a sea passage on to Constantinople.

At the close of the War, the « Simplon Orient Express » took its place but both routes have been altered since, and a third one, the « Arlberg Express » route, added.

(1) The Netherlands Railways' timetable quotes 144 km. from Amsterdam to Roosendaal. The Belgian timetable (table 12), 148 km.

The French timetable quotes 71 + 151, i. e. 222 km. from Strasbourg to Luxemburg, whereas the Belgian timetable (No. 162) gives the distance as 225.

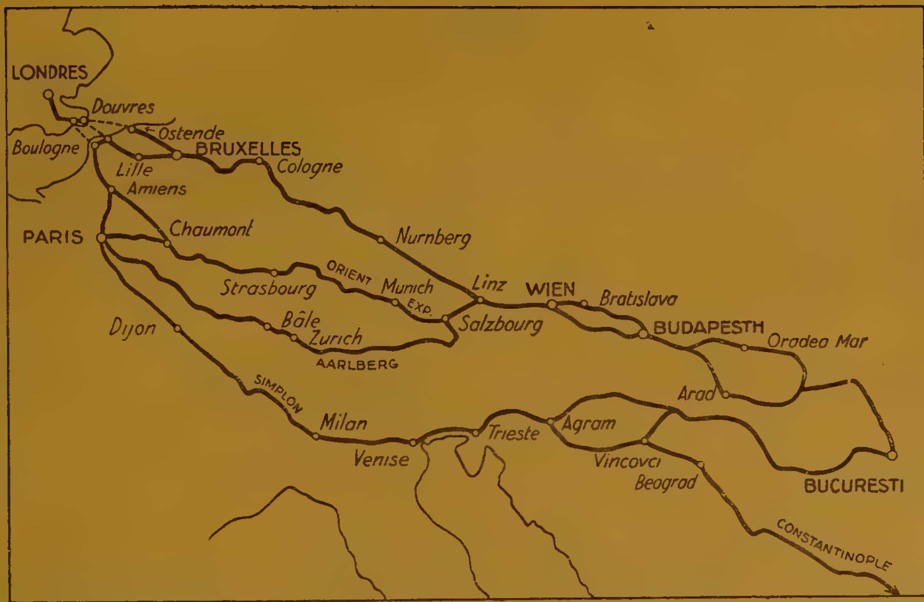


Fig. 6. — Various competing routes from London and Paris to Vienna, Bucarest and Istanbul.

TABLE 18.

PARIS AND ISTANBUL.

ROUTE	Time of departure.	Time spent.	Distance.		Speed.	
			Km.	Miles.	Km./h.	Miles/h.
Orient Express via *Constantza.* .	*7.13 p. m.*	*62 h. 45*	*3 208*	*1 993*	*49.9*	*31.0*
Orient Express (Paris *Est*) . . .	7.55 p. m.	59 h. 50	3 124	1 941	52.2	32.4
Simplon-Orient Expr. (P.-L.-M). .	7.40 p. m.	58 h. 45	3 206	1 992	54.6	34.0

There is but little competition, save in the first stages of the journey, the only ones where reasonable speeds are maintained.

TABLE 19

PARIS AND BUCAREST.

ROUTE	Time of departure.	Time spent.	Distance.		Speed.	
			Km.	Miles.	Km./h.	Miles/h.
Orient Express (Paris *Est*) via Arad.	7.55 p. m.	43 h. 55	2 586	1 607	59.0	36.7
Arlberg Express (Paris *Est*) via Oradea Mare	7.55 p. m	46 h. 00	2 676	1 663	58.0	36.0
Simplon-Orient Express. . . .	7.40 p. m.	51 h. 00	2 690	1 672	52.8	32.8

The recent acceleration of the « Arlberg Express » has enabled it to compete with the « Orient Express », particularly between Paris and Vienna.

TABLE 20.

PARIS AND VIENNA.

ROUTE.	Time of departure.	Time spent.	Distance		Speed	
			Km.	Miles.	Km./h.	Miles/h.
Vienna-Paris *Est* (Orient Express).	2.5 p. m.	20 h. 40	1 384	860.0	66.6	41.4
Vienna-Paris *Est* (Arlberg Expr.) .	12.10 noon.	22 h. 00	1 490	925 8	67.7	42.1

CHAPTER IV.

Speed of different kinds of trains.

IV-1. — **« De luxe » and Pullman trains.** — For a long time most « de luxe » trains ran at higher speed than others and such is still the case in the greater part of Eastern Europe. As the payment of a supplementary charge is imposed for using them, it is necessary to quote, as well, the speed of other trains. But it should be remembered in their favour, that it is owing to them that international and long distance travelling has been developed and made easy on the Continent.

Most of the Pullman trains are day trains, running within the boundaries of one country. We quote them in table 21. Other « de luxe » trains are mostly international ones, with frontier delays and often slow travelling at night. We also quote them, but in Part II, when examining the services of the *International Sleeping Car Co.*

British all -Pullman trains are quoted in Part II, Chapter VII (par. 3) when dealing with British services.

As a rule, the speed of these trains is high in the first part of their journey and diminishes as one gets further away.

TABLE 21.

OVERALL SPEED OF INTERNATIONAL AND A FEW NATIONAL CONTINENTAL ALL-PULLMAN TRAINS.

(The services shown in italics are obsolete.)

NAME OF TRAIN.	RUN.	Distance Km.	Distance Miles.	Time of departure.	Time spent.	Speed Km./h.	Speed Miles/h.
Brussels-Calais Pullman. . .	Brussels (N.)-Calais (Mar.).	217	135	9.3 a. m.	2.56	73.9	46.0
Do.	Boulogne-Brussels (N.).	260	162	5.35 p. m.	3.24	76.5	47.5
Ostend-Cologne Pullman. . .	Ostend (Q.)-Brussels (N.)-Cologne.	341	212	R10.40 a. m.	5.05	67.1	41.7
Le Côte d'Azur Rapide . . .	Paris P.-L.-M.-Menton.	1 108	689	9.0 a. m.	14.11	78.1	48.6
Danubiu Rapide	Bucarest-Galatz.	260	162	6.20 p. m.	3.55	66.4	41.2
Regele Carol I	Bucarest-Constantza.	227	141	6.0 p. m.	3.17	69.1	42.9
Edelweiss	Amsterdam-Basle-Zurich.	884	549	10.41 a. m.	12.58	65.7	40.8
L'Etoile du Nord	Paris-Brussels-Amsterdam.	539	335	R12.41 noon	7.04	76.3	47.4
Milan-S.Remo-Nice-Cannes . .	Milano-S. Remo-Nice-Cannes.	372	231	9.0 a. m.	7.55	47.2	29.3
L'Oiseau bleu.	Paris-Brussels-Antwerp.	362	225	R 9.50 a. m.	4.10	86.9	54.0
The Golden Arrow	Paris-Calais (Maritime).	299	186	12.0 noon	3.10	94.4	58.6
Gothard Pullman Express . .	*Milan-Basle.*	*371*	*230.5*	*4.25 p. m.*	*6.20*	*54.4*	*33.8*
Andalousie Express	*Sevilla-Grenada.*	*288*	*179*	*8.0 a. m.*	*7.15*	*39.7*	*24.6*
The Sunshine Express (Winter)	Cairo-Luxor.	674	416.6	6.30 p. m.	12.00	56.2	34.9

The same applies to residential trains, such as those running to the Riviera or the Côte d'Argent, which are fast until they get to the district and slow beyond, stopping at most stations. This really does not matter as passengers get in or out at most of these places and the scenery is admirable. But in order to appreciate their service one should consider the speed of the run both up to the residential district and on to its terminus.

Since trains of late have been getting so heavy, and since most international « de luxe » trains are made up of rakes coming from several directions and going to a number of different points, their speed is no longer the crack speed of the line they run over. Besides this, owing to the inclusion of 2nd and sometimes of 3rd-class passengers as well, they are no longer exceptional expresses and others are often as fast, if not faster.

IV-2. — **Speeding up of ordinary passenger trains.** — In order to recover some of the short-distance traffic benevolently given up to the roads, most railways have systematically started speeding up their slow trains, and this policy has been a profitable one.

In France, the *Nord Ry.* has done this serially. Powerful locomotives are used and stops reduced to 15 seconds each, which has helped to raise average speeds by 20 % (up to 42 km. or 26 miles an hour) and in some cases, to bring this speed up to 47 km. (32 miles) an hour

and thus effectively meeting motorbus competition.

Since April 15th, 1932, Italy has done the same. Stopping trains are made up of two classes and sometimes of one only (3rd); they stop 30 seconds only at each station. Here are a few examples.

TABLE 22.

SPEEDING UP OF STOPPING TRAINS IN ITALY.

RUN.	Distance		Reduction of the time taken	
	Km.	Miles.	from (minutes)	to (minutes)
Aqui to San Giuseppe	50	31	123	72
Trento to Verona	92	57	152	112
Pisa to Empoli and Florence	79	49	120	80

IN ENGLAND, the road motor expresses compelled the railways to speed up, not their stopping trains only, but their semi-stopping trains as well.

Thus on the *L. and N. E. Ry.*, five pairs of these trains, made up of new and special rolling stock, have been put on between King's Cross and Cambridge (93 km. = 58 miles), and the runs are made in from 72 to 75 minutes, including three stops. This works out at an average speed of 74.5 to 77.5 km. (46.3 to 48.2 miles) an hour. Table 23 quotes other instances of this Company's short fast runs in the North Eastern area.

TABLE 23.

SPEEDING UP IN THE YORK DISTRICT (L. & N. E. RY.)

RUN.	Time spent (minutes).	Distance		Speed		Number of intermediate stops.
		Km.	Miles.	Km./h.	Miles/h.	
York to Bridlington	55	77.5	48.2	84.6	52.6	0
Do. to Hull	57	68.7	42.7	72.3	44.9	1
Do. to Scarborough	55	67.6	42	73.7	45.8	1

As the BELGIAN RYS. have not enough railcars, they have been running a series of « T » trains (colloquially known as « trottinettes »), consisting of a couple of carriages with a seating capacity of 110, drawn by small discarded 4-4-2 tank engines. This is, of course, more costly than running railcars would be, but as in some districts, the public had completely deserted the railways in favour of the motorbuses, it was a question of making a bid for this lost traffic or definitely giving it up. For this purpose, the « T » trains stop 10 seconds only at all stations and halts, whose number has even been increased. They have been timed at 60 km. (37.3 miles) an hour, one minute for each halt — which is ma-

nifestly insufficient — being added each time for deceleration, time spent stopping and acceleration.

In practice, many stops take longer than the 10 seconds allotted, but the trains keep to their schedules. This requires very quick acceleration — which is easy as the trains are light — and the maintenance between the stops, which are often absurdly close together, of running speeds of 80 km. (50 miles) an hour and often more. These « T » trains are, in fact, high-speed tramways and their pecuniary results have been eminently satisfactory, for not only have the most optimistic expectations been fulfilled, but in most cases they have been exceeded. The public has returned to the railways and deserted the buses and many of the « T » trains run with full loads and passengers standing in the corridors and in the vestibules. This brings the total nomber up to 200 — with seating capacity for 110 only (16 2nds and 92 3rds.).

This experiment is valuable, because it shows how trains formed of stock otherwise unemployed have produced appreciable benefits despite costly operation, thanks to traffic they have recovered from motorbuses. They prove how useful it is to run short, numerous high-speed services — for which railcars would be more suitable, if they have sufficient power. For it should not be lost sight of that the « T » trains which weigh 116 tons, with a 64-ton locomotive included, have 800 H. P., all of which is called upon on certain of the hard services they are used for, such as those from Brussels (Q.-L.) to Ottignies.

TABLE 24.

A FEW BELGIAN LIGHT HIGH-SPEED TRAINS (T. AND TT. TRAINS).

SERVICE.	Train number.	Time of departure.	Time spent.	Number of intermediate stops.	Distance		Speed.	
					Km.	Miles.	Km./h.	Miles/h.
			Minut.					
Antwerp and Esschen . .	T. 1501	6.38 a. m.	51	12	33	20.5	39	24.2
Do. and Turnhout. .	T. 1032	9 24 a. m.	60	14	52	32.3	52	32.3
Do. and Lierre and Louvain.	TT. 628	7.54 a. m.	82	24	59	36.7	43.7	27.1
	522	*9.12* a. m.	*101*	*10*			*35.1*	*21.8*
Brussels (N.) and Malines .	T. 901	7.35 a. m.	28	5	21	13.0	45	28.0
	4211	*6.13* a. m.	*44*	*5*			*28.6*	*17.8*
Courtrai and Bruges . .	TT. 1107	2.00 p. m.	74	17	53	32.9	43	26.7
	2808	*12.12noon.*	*105*	*15*			*30.3*	*19.0*
Liége and Verviers . . .	T. 188	12.15 p. m.	28	1	25	15.5	53.5	33.2
	165	*1.27* p. m.	*33*	*1*			*45.5*	*28.3*
	T. 182	7 1 a. m.	47	11			31.9	19.9
	566	*5.13 a m.*	*64*	*10*			*23 4*	*14.6*
Brussels (Q.L.) and Ottignies	TT. 302	6.13 a. m.	31	10	23	14.3	44.5	27.6
	T. 312	10.17 a. m.	35	12			39.4	24 5
	D. 142	*2. 8* p. m.	*44*	*9*			*31.4*	*19.5*
	1226	*9 9* a. m.	*25*	*0*			*55.2*	*34.3*
	134	*8.50* a. m.	*39*	*3*			*35.4*	*22.0*

The first runs are across flat country, but Liége-Verviers is on a constant gradient, and the Brussels-Ottignies line has up and down gradients of 1 in 63.

We have shown in italics similar services of ordinary trains. These comparisons do not require any commentary.

TABLE 25

NUMBER OF PASSENGERS CARRIED DURING A GIVEN PERIOD.

ROUTE.	Daily average. A. Light trains. (Week 10th to 16th Oct. 1932)	Daily average. B. Ordinary trains. Before the light trains were put on
Antwerp and Lierre.	12 260	10 656
Lierre and Heyst o/d Berg	1 493	1 388
Aerschot and Do.	1 503	1 265
Brussels and Termonde	6 358	4 383
Roulers and Menin.	785	669
Charlerci and Courcelles	2 079	1 053
Courcelles and Piéton.	1 473	1 020
Charleroi and Fleurus.	4 637	3 500
Charleroi and Châtelineau.	5 532	4 272
Châtelineau and Tamines	4 378	3 365
Tamines and Jemeppe s/S.	2 749	2 058
Brussels and Ottignies	6 029	5 478
Verviers and Spa	3 801	2 414

The difference between the numbers in columns A and B (Table 25) corresponds to the growth of traffic resulting from the introduction of the light trains. It is not possible to indicate the loss to the competing motorbuses, as these are worked by private firms.

IV-3. — **Goods trains.** — After speeding up passenger trains, the same methods have been applied to goods trains, whose competition with motor lorries had even worse consequences. For this purpose, not only has it been necessary to increase their running speed, but also to simplify all formalities in connection with the dispatch or reception of goods and even to make provision for collecting and delivering them at latest on the day following that of dispatch.

ENGLAND. — On the *Great Western Ry.* certain goods trains from London to Plymouth (consisting of 70 wagons and weighing up to 700 or 800 tons) are timed at a speed of 61.9 km. (38 1/2 miles) per hour from Paddington to Newbury (85.3 km. = 53 miles) and at a speed of 56.3 km. (35 miles) an hour from Newbury to Newton Abbott (227.7 km. = 141.5 miles) in spite of gradients of 1 in 106 and 1 in 80.

On the London Midland and Scottish Railway, the train from London (Camden Town) to Liverpool (Edge Hill), a distance of 307.4 km. (191 miles), has recently been accelerated to run at an average speed of 62.8 km. (39 miles) an hour.

The accelerations on the *London and North Eastern Railway* have saved an hour on the run from London (King's Cross) to Glasgow (High St. Goods Station). These goods trains cover the 702 km. (436 miles) at a speed of 62.8 km. (39 miles) an hour, with a maximum overall speed of 88.5 km. (55 miles) an hour.

The « Scotch goods » was started in 1897 and then took 16 hours to run the 708 km. (440 miles) from London (King's Cross) to Glasgow (1). It now only takes 13 h. 38 min., 2 h. 25 m. of which are taken up in stops for traffic purposes. The running speed works out therefore at 63.9 km. (39.7 miles) an hour for the whole journey, and from London to Berwick, at 67.5 km. (41.9 miles) an hour. The non stop run from Westwood Junction, Peterborough to Severus Junction,

(1) Left at 3.25 p. m.; arrived at 7.25 a. m. — Today, leaves at 3.40 p. m.; arrives at 5.18 a. m.

York, of 180 km. (111.9 miles) is accomplished at 70.5 km. (43.8 miles) an hour. This train of 50 wagons and a brake carries ordinary goods (non-perishable).

There are, on the system, 119 goods trains (meat or fish), completely or partially braked, which allow of delivery the next morning. Here are a few examples of their running.

TABLE 26.

FAST GOODS TRAINS OF THE LONDON & NORTH EASTERN RAILWAY.

PARCOURS.	Distance		Overal speed	
	Miles.	Km.	Miles/h.	Km./h.
London to Clarence Yard	389	626	41.2	66.3
Glasgow to London (Marylebone)	470	756	37.7	60.6
Aberdeen to London (King's Cross)	523	841	44.0	70.8
Newcastle to Liverpool	196	315	39.9	64.2
London (King's Cross) to Manchester	210	338	32.3	52.0
London (King's Cross) to Leeds	186	300	35.5	57.0

Great Western Ry. Class C (partially braked) express goods, are timed over easy sections at a speed of 64 km. (40 miles) and some even at 72.4 km. (45 miles) an hour. They are made up of 45 wagons conveying general goods.

Trains of 70 wagons, one third braked, all with oil axle boxes, also run at express speeds. 60 of them run daily, some covering long non-stop stretches.

TABLE 27.

FAST GOODS TRAINS OF THE GREAT WESTERN RAILWAY.

RUN.	Time of departure.	Number of wagons.	Distance		Speed	
			Miles.	Km.	Miles/h.	Km./h.
Old Oak Common to Penzance. Newbury Race Course to Newton Abbot	9.32 a. m.	45W.+B.	141	227	40	64.4
London (Paddington) to Birkenhead. Greenford, Shrewsbury (Cott. Hill)	9.10 a. m.	45W.+B.	145	233	38.6	62.2
London (Paddington) to Newton Abbot, Acton, Swindon and Taunton	11.35 a. m.	70W.+B.	152	244	33.5	53.9

Class E' « accelerated goods trains » consist of 70 wagons with grease axle boxes, with 4 to 9 braked wagons immediately back of the engine. The maximum authorised speed is 56.3 km. (35 miles) an hour.

« Class F » has a maximum speed of 40.2 km. (25 miles) an hour only.

In the UNITED STATES the average speed of all the goods trains, including all delays and stops, was in March 1930, 22.2 km. (13.8 miles) an hour; this has been improved since, thanks, in particular, to the speeding up of the express goods trains.

Thus, the « Blue Streak » of the *St. Louis & South Western R. R.* loads in St. Louis for the Cotton Belt, some 500 to 600 miles away, and whilst leaving in the evening only, allows delivery to be made everywhere by next morning [1]. Competition of road traffic has been checked and some of its traffic won back.

The « Speed Witch » of the *Pennsylvania R.R.* covers the 660 km.(412 miles), from Baltimore to Boston, at a speed of 42.2 km. (26.2 miles) an hour.

Southwards, the speed of 57.6 km. (37.3 miles) an hour excluding stops is maintained over the 274.6 km.(176 miles) from Jersey City to Baltimore.

Taken as a whole, the speed of all American freight trains has been increased by 17 % since 1929 and, owing to the withdrawal of old locomotives from service, the number of ton-miles has been increased by 10 %. The newer locomotives, mostly in use, run double the number of miles between heavy repairs [193 000 km., instead of 97 000 (120 000 miles instead of 60 000)]. But what would happen were the former traffic to return to the railways, making it necessary to wake the old locomotives from their long sleep, is not quite clear.

(1) Leaving St. Louis at 6.0 p. m. with a shunting locomotive and East St. Louis at 7.10 p. m. with a main line locomotive, it covers in 3 hours non-stop the 204.2 km. (126.9 miles) to Ilmo, at a speed of 68.1 km. (42.3 miles) an hour. 1 3/4 hours are taken for the 103.6 km. (64.4 miles) to Malden, where the train arrives at midnight; average speed, 59.2 km. (36.8 miles) an hour.

With all intermediate stops, the entire distance of (941 km. = 584.7 miles from St. Louis) to Shreveport (night) is run at an average speed of 53.3 km. (33.1 miles) an hour from East St. Louis, and of 50.5 km. (31.3 miles) an hour from St. Louis itself.

These improvements and others have rapidly borne fruit.

In SWEDEN up to date methods are also current. Thus, when road vehicles managed to deliver newspapers in the provinces more expeditiously than did the railways, the latter tried to recapture this traffic, a valuable one which produced 329 827 Kr. of gross receipts in 1931 and 18 894 Kr. ordinary goods receipts at the Stockholm Central Station alone. The railways showed their initiative by running special newspaper trains which carried the newspaper staff free, thus enabling them to address and make the papers up into packets « en route » and to leave Stockholm at the very latest moment. Not only was the whole of the traffic recovered, but provincial sales increased.

CHAPTER V.

Present-day speeds.

Table 28 gives the fastest non-stop runs of most of the European and a few North American Railway Companies or Administrations and table 33, the longest non-stop runs.

It is curious that certain figures have a kind of fascination for the mass. In England, for a long time, a speed of « 50 » miles an hour was the goal and at the end of last century, it was hoped that our own would see speeds of « 60 » miles an hour — a mile a minute — which has been the case since a long time.

Table 28

FASTEST RUNS IN VARIOUS COUNTRIES.

In this table, obsolete runs are shown in italics.

The figures have been taken from the timetables in use on May 15th, 1933, for Continental trains and in Summer, for the English ones save certain of them, which have been supplied direct by the Administrations concerned.

In the column relating to the runs, we have added in parentheses, the names of places where the trains come from or go to, the actual run being made between the two places which are not in parentheses.

The letter R which figures occasionally before the time of departure means that the train quoted runs from the second of the places to the first (return direction).

When several trains cover the same route at the same speed, we have only quoted one of them.

COMPANY OR ADMINISTRATION.	RUN.	Distance.		Time of departure.	Time spent.	Speed	
		Km.	Miles.			Km./h	Miles/h.
1. GERMANY.							
Reichsbahn	Berlin (Lehrte)-Hamburg.	**287.0**	**178.4**	**8.2** a. m.	**2.18**	**124.1**	**77.1**
	Do.	Do.	Do.	6.5 p. m.	2.43	105.6	65.6
2. GREAT BRITAIN.							
Great Western Ry	Swindon-Paddington.	124.4	77.3	3.55 p. m.	1.05	114.9	71.4
Do.	Paddington-Bath.	172.0	106.9	11.15 a. m.	1.44	99.3	61.7
London Midland & Scottish Ry.	Crewe-Willesden Jn.	245.4	152.5	6.12 p. m.	2.22	103.8	64.4
Do.	Stafford-Euston.	215.0	133.6	6.45 p. m.	2.07	101.5	63.1
London & North Eastern Ry.	Grantham-King's Cross.	169.4	105.5	9.40 a. m.	1.40	101.9	63.3
Do.	Huntingdon-King's Cross.	94.8	58.9	9.31 a. m.	57'	99.8	62.0
Southern Ry	Waterloo-Salisbury.	134.6	83.6	3.00 p. m.	1.27	92.8	57.7
3. CANADA.							
Canadian Pacific	Smiths Falls-Montreal West.	199.5	124.0	. .	1.48	110.9	68.9
Do.	Trenton-Oshawa.	115.4	71.7	...	1.09	100.3	62.3
Canadian National	Brockville-Cornwall.	93.5	57.9	...	55'	101.7	63.2
Do.	Belleville-Oshawa.	128.4	79.8	. .	77'	100.1	62.2
4. FRANCE.							
State Rys.	Paris (St-Laz.)-Deauville.	**221.0**	**137.3**	1.50 p. m.	**2.00**	**110.5**	**68.7**
Do.	Trouville-Port l'Evêque.	**19.0**	**11.8**	**7.38** a. m.	**11'**	**103.6**	**64.8**
Do.	Paris (St-Laz.)-Rouen.	140.0	86.9	8.20 a. m.	1.23	101.2	62.8
Alsace-Lorraine	(Basle) Mulhouse-Strasbourg (Brussels).	109.0	67.7	9.44 a. m.	1.01	107.2	66.6
Do.	(Brussels) Metz-Strasbourg.	159.0	99 0	R 10.50 a. m.	1.32	103.7	64.4
Nord	Paris-St-Quentin (Brussels).	154.0	95 7	1.36 p. m.	1.28	105.0	65.2
Do.	Paris-Arras (Lille).	199.0	123 6	8.15 a. m.	1.54	104.7	65.0
Do.	Paris-Aulnoye (Brussels).	216.0	134.2	8.0 p. m.	2.06	102.8	63 8
Do.	Paris-Etaples (Calais).	227.0	141.1	10.0 a. m.	2.12	102.4	63.6
Do.	Compiègne-St-Quentin.	70.0	43.5	7.13 p. m.	42'	100.0	62.1

R. — This run is return working.

COMPANY OR ADMINISTEATION.	RUN.	Distance Km.	Distance Miles.	Time of departure.	Time spent.	Speed Km./h.	Speed Miles/h.
Est	Paris (Est)-Bar-le-Duc (Nancy)	253.0	157.8	R 10.10 a. m.	2.30	101.6	63.1
Do.	Bar-le-Duc-Nancy.	99.0	61.5	R 9 9 a. m.	59′	100.7	62.5
Paris-Orléans	(Paris) Les Aubrais-St-Pierre-des-Corps (Bordeaux).	112.0	69.6	12 25 noon	1.07	100.3	62.2
Paris-Lyons-Mediterranean	(Paris) Valence-Avignon.	124.0	77.0	4.26 p. m.	1.19	94.2	58.6
Midi	Bordeaux-Dax.	148.0	91.9	5.22 p. m.	1.37	91.5	56.8
5. U.S.A.							
Philadelphia & Reading R. R.	Egg Harbor-Pleasantville.	19.2	11.9	...	11′	103.8	64.5
Pennsylvania R. R.	Egg Harbor-Asecon.	17 2	10.7	...	10′	103.3	64.2
	Plymouth-Fort Wayne.	103.2	64.1	..	1.01	101.4	63 0
	Gary-Plymouth.	94.4	58.7	...	56′	101.2	62.9
New York Central Lines.	Galion-Linndale.	118.8	73.8	...	1.10	101.9	63.3
	Elkhart-Toledo.	209.7	133.0	...	2.08	100.3	62.3
Chicago and North Western.	Evanston-Waukegan.	38.5	23.9	...	23′	100.3	62.3
6. OTHER COUNTRIES.							
ITALY. — State Rys.	Milan (Verona-Padova). (Venice).	82.0	51.0	11.4 a. m.	50′	98.4	61.4
IRELAND. — Gt. North. Ry.	Dublin (Amiens St)-Dundalk.	*86.9*	*54.3*	*8.15 p. m.*	*54′*	*96.6*	*60.3*
Do. Gt. South. Ry.	Dublin (Kingsbridge)-Maryborough.	82.0	51.0	6.40 p. m.	1.00	82.0	51.0
BELGIUM. — Nation. Ry Co.	Brussels (N.)-Ostend (Q.).	116.9	72.7	*2.20 p. m.*	*1.20*(1)	*87.7*	*54.5*
	Brussels (M.)-Mons.	61.0	37.9	8.56 a. m.	*43′*	85.0	52.8
Do. Nord belge	Liége (Guill.)-Namur.	60.0	37.3	*5.43 p. m.*	43′(1)	*83.7*	*52.0*
SWITZERLAND. — Federal	Göschenen-Bellinzona.	103.0	64.0	10.39 a. m.	1.14	83.5	51.9
Do. Rhætic.	Coire-Samaden.	127.0	79.0	8.14 p. m.	2.16	56.0	34.8
HOLLAND. — Netherl. Rys.	Rosendaal-Flushing.	75.0	46.6	12.44 noon	54′	83.3	51.8
POLAND. — State Rys.	(Warsaw) Poznan-Zbaszyn.	75.0	46 6	5.10 p. m.	54′	83.3	51.8
AUSTRIA. — Federal Rys.	Vienna (S.)-Semmering.	129.0	80.2	8.30 a. m.	1.30	86.0	53.4
	Vienna St. Pölten-Linz.	128 0	79.6	8.56 a. m.	1.34	81.7	50.7
HUNGARY. — State Rys.	Budapest (East)-Hatvan.	69.0	42.9	12.18 night	50′	80.7	50.1
RUMANIA. — State Rys.	Bucarest (N.)-Ciulnita. Constanza).	109.0	67.7	6.0 p. m.	1.21	80.7	50.1
CZECHOSLOVAKIA. — State.	(Prague) Prerov N.-Ostrava.	84.0	52.2	R 2 33 p. m.	1.06	76.4	47.5
7. 3 ft.-6 in. gauge lines.							
JAVA. — State Rys.	(Batavia) Solo-Madioen (Soerabaia).	97.9	60.8	...	1.14	75.3	46 8
JAPAN. — State Rys.	Kozu-Shizuoka.	114.3	71.0	...	1.33	73.8	45.9

R — This run is the return working. — (1) These services have now been decelerated.

TABLE 29.

THE FASTEST TRAINS.

In *italics* : Runs now suppressed. — In **heavy type** : Railcar runs.

COMPANY OR ADMINISTRATION.	RUN.	Distance. Km.	Distance. Miles.	Speed. Km/h.	Speed. Miles/h.
1. Non-stop runs at an average speed of over 100 km. (62 miles) an hour.					
GERMANY. — Reichsbahn.	**Berlin (Lehrte)-Hamburg.**	**287.0**	**178.4**	**124.1**	**77.1**
ENGLAND. — Great Western Ry.	Swindon-Paddington.	124.4	77.3	115.9	71.4
CANADA. — Canadian Pacific.	Smiths Falls-Montreal.	199.5	124.0	110.9	68.9
FRANCE. — State.	**Paris-Deauville.**	**221.0**	**136.8**	**110.5**	**68.7**
Alsace-Lorraine.	Mulhouse-Strasburg.	109.0	67.7	107.2	66.6
GERMANY. — Reichsbahn.	Berlin-Hamburg.	287.0	178.4	105.6	65.6
FRANCE. — State.	**Trouville-Port l'Evêque.**	**19.0**	**11.8**	**103.6**	**64.8**
Do. Nord.	Paris-Saint-Quentin.	154.0	95.7	105.0	65.2
Do. Do.	Paris-Arras (Lille).	199.0	123.6	104.7	65.0
ENGLAND. — London, Midland & Scottish.	Crewe-Willesden Jn.	245.4	152.5	103.8	64.4
U. S. A. — Philadelphia & Reading.	Egg Harbor-Pleasantville.	19.2	11.9	103.8	64.5
FRANCE. — Alsace-Lorraine.	(Brussels) Metz-Strasburg.	159.0	99.0	103.7	64.4
U. S. A. — Pennsylvania R. R.	Egg Harbor-Asecon.	17.2	10.7	103.3	64.2
FRANCE. — Paris-Orleans.	Les Aubrais-St-Pierre-des-Corps	112.0	69.6	100.3	62.2
ENGLAND. — London & North Eastern Ry.	Grantham-King's Cross.	169.4	105.5	101.9	63.3
U. S. A. — New York Central.	Galion-Linndale.	118.8	73.8	101.9	63.3
CANADA. — Canadian National.	Brockville-Cornwall.	93.2	57.9	101.7	63.2
U. S. A. — Chicago & North Western.	Evanston-Waukegan.	38.5	23.9	100.3	62.3
2. Companies or Administrations having non-stop runs carried out at a speed of 90 to 100 km. (56 to 62 miles) an hour.					
ITALY. — State.	Verona-Padova.	82.0	51.0	98.4	61.4
IRELAND. — Great Northern Ry.	Dublin-Dundalk.	86.9	54.3	96.6	60.3
FRANCE. — Paris-Lyons-Mediterranean.	Valence-Avignon.	124.0	77.0	94.2	58.5
Midi.	Bordeaux-Dax.	148.0	91.9	91.5	56.[illegible]

COMPANY OR ADMINISTRATION.	RUN.	Distance		Speed	
		Km.	Miles.	Km./h.	Miles/h.
3. Companies or Administrations having non-stop runs at a speed of 80 to 90 km. (50 to 56 miles) an hour.					
BELGIUM. — Nation. Ry. Co.	Brussels (N.)-Ostend (Q.).	*116.9*	*72.7*	*87.7*	*54.5*
AUSTRIA. — Federal Rys. .	**Vienna (S.)-Semmering.**	**129.0**	**80.2**	**86.0**	**53.4**
SWITZERLAND. — Fed. Rys.	Göschenen-Bellinzona.	103.0	64.0	83.5	51.9
HOLLAND. — Netherl. Rys.	Rosendaal-Flushing.	75.0	46.6	83.3	51.8
POLAND. — State	(Warsaw) Poznan-Zbaszyn.	75.0	46.6	83.3	51.8
AUSTRIA. — Federal Rys. .	(Vienna) St. Pölten-Linz.	128.0	79 6	81.7	50.7
HUNGARY. — State. . . .	Budapest (East)-Hatvan.	69.0	42.9	80.7	50.1
RUMANIA. — State. . . .	Bucarest (N.)-Ciculnita.	109.0	67.7	80.7	50.1

On the Continent, speeds of « 80 », then « 90 », « 100 » and even « 120 » kilometres an hour, were the objective. And on quite a number of systems, « 120 » kilometres an hour, was the maximum authorised speed. Why « 120 » rather than, say, « 115 » or « 125 »? Simply because 120 km. an hour is 2 kilometres a minute — which is no reason at all. But it must serve, because there is no other.

As a matter of fact, there is no very great difference between the British «50» miles and the Continental « 80 » kilometres; nor is there so very great a margin between « 60 » miles (96 km.) and « 100 » kilometres (62.5 miles)

And now all these figures have been reached and exceeded by no less than four French Companies (the *Alsace-Lorraine*, the *Nord*, the *Est* and the *Paris-Orleans*) and three English ones (the *G. W.*, the *L. M. and S.* and the *L. and N. E.*). Further, Canadian trains run at over 65 miles an hour, and the *Great Western*, at over 70.

Besides this, express railcars open the way to still higher speeds and have already attained average speeds in every day service of 124.6 km. (77.4 miles) an hour, and 110.5 km. (68.6 miles) in France.

Speeds reached and maintained between two given points where no stops are made are necessarily much higher than the average speeds, and lie outside our subject. In spite of this, we quote the fast French *Nord* Ry.'s runs from Paris the the Belgian frontier. The 237.9 km. (147.8 miles) from Paris to Jeumont, are covered at the average speed of 106.5 km. (66.2 miles) an hour and the (234.6 km. = 145.8 miles) from Paris to Quévy at an average of 102 km. (63.4 miles) an hour.

Without minimising the value of such performances carried out daily with heavy trains running absolutely to time, it should be remarked that a frontier of this kind is an artifical limit; were the run considered over the adjoining *Nord*

Belge as well, the results quoted would be diminished.

If we started doing this, it would be necessary to consider other runs from pass to pass, or from pass to stop, which would modify all our lists in a platonic sort of way; platonic, because the actual time the journey takes would not be affected. The following examples are taken from the *Southern Railway's* working timetables.

ROUTE.	Distance		Time of departure.	Time spent.	Speed	
	Km.	Miles.			Km. h.	Miles h.
Weymouth to Waterloo (2 intermediate stops)	237.1	147.3	7.32 a. m.	3.08	75.6	47.0
Woking Junction (pass) to Hampton Court Jn. (pass)	18.2	11.3	pass.	0 10	110.7	68.6
Basingstoke (pass) to Woking Jn. (pass)	38.0	23.6	pass.	0.20 1/2	108.5	67.5
Basingstoke (pass) to Waterloo (stop)	76.7	47.7	pass.	0 47	114.6	71.1

V-1. — The fastest runs take place in England, Canada, France and Germany, then in Italy, followed by Ireland where speeds of over 90 km. (56 miles) an hour are to be found.

Speeds of 80 km. (50 miles) an hour exist in most other countries of Western and Central Europe.

Germany and Italy are newcomers among high-speed countries and have made a considerable effort in a very short time to bring themselves within this category.

It is curious to note, however, that the fastest runs have not been much improved during the first quarter of this Century, and that it is only within recent years that further advances have taken place. The table giving the fastest British runs from 1847 up to the present time shows this strikingly :

TABLE 30.

FASTEST BRITISH RUNS OF OVER 80 KM. (50 MILES).

DATE. (Year)	Speed		Company.
	Miles/h.	Km. h.	
1847	57.6(1)	92.7	Great Western Railway.
1871	53.2	85.6	Do.
1883	53.2	85.6	Do.
1898	55.3	89.0	Great Northern Railway.
1907	59.4(2)	95.6	Great Central Railway.
1914	59.2(2)	95.3	Do.
1925	61.8	99.5	Do.
1929	66.2	106.5	Do.
1932	71.4	114.9	Great Western Railway.

(1) The run quoted for 1847 was decelerated after 1851.

(2) The fastest speeds took place on shorter runs. Thus the North Eastern Railway reached 99.3 km. (61.7 miles) in 1907 and 1914.

The running time between two places has not been reduced as much as might have been expected. The following table, comparing the times from London to the main provincial centres on each of the railways since 1888 (i. e. after the first important acceleration of the services) is still more convincing.

TABLE 31.

RUNNING TIMES BETWEEN LONDON AND THE MAIN PROVINCIAL TOWNS IN 1888 AND 1933 [1]

From London to	Company.	Running Time in October 1888.	Running Time in January 1933.	Time saved in minutes.	Time saved in %.
Birmingham	London and North Western Ry	2 h. 40 m.	2 h. 00 m.	40	25
Edinburgh		8 h. 30 m.	8 h. 00 m.	30	6
Liverpool		4 h. 25 m.	3 h. 35 m.	50	19
Manchester		4 h. 15 m.	3 h. 15 m.	60	23
Manchester	Midland Ry	4 h. 15 m.	3 h. 56 m.	19	7
Nottingham		2 h. 25 m.	2 h. 09 m.	16	9
Birmingham	Great Western Ry	2 h. 42 m.	2 h. 00 m.	42	26
Bristol		2 h. 36 m.	1 h. 58 m.	38	24
Cardiff		3 h. 15 m.	2 h. 45 m.	90	35
Oxford		1 h. 18 m.	1 h. 10 m.	8	10
Plymouth		5 h. 49 m.	4 h. 07 m.	42	12
Edinburgh	Great Northern Ry	8 h. 30 m.	7 h. 45 m.	45	9
Leeds		3 h. 55 m.	3 h. 14 m.	41	17
Manchester		4 h. 15 m.	4 h. 05 m.	10	4
Cambridge	Great Eastern Ry	1 h. 15 m.	1 h. 15 m.	0	0
Norwich		3 h. 00 m.	2 h. 30 m.	30	17
Bournemouth	London and South Western Ry	2 h. 29 m.	2 h. 00 m.	29	19
Portsmouth		1 h. 58 m.	1 h. 39 m.	19	16
Southampton		1 h. 39 m.	1 h. 29 m.	10	10
Weymouth		4 h. 07 m.	3 h. 14 m.	53	21
Brighton	London, Brighton and South Coast	1 h. 05 m.	1 h. 00 m.	5	7
Eastbourne		1 h. 33 m.	1 h. 22 m.	11	12
Hastings	South Eastern Ry	1 h. 35 m.	1 h. 35 m.	0	0
Margate	London, Chatham and Dover Ry	1 h. 45 m.	1 h. 33 m.	12	11

(1) Table compiled by Reginald B. Fellows.

After the races of 1895 another general speeding up took place, which resulted in much the same times as those of 1932 :

TABLE 32.

ROUTE.	Speed in 1896.	Speed in 1932.
King's Cross-Edinburgh	7 h. 25 (3 intermediate stops)	7 h. 30 (non-stop)
Newcastle-Edinburgh	137 m.	145 m.
Crewe-Carlisle (L.M.S.Ry.)	160 m.	164 m.
Wigan-Carlisle	112 m.	125 m.
Carlisle-Stirling (Caledonian Ry.)	125 m.	145 m.

Of course, the weight of the trains at the period could not compare with that of present-day trains. But it should not be forgotten that the power of the locomotives has increased almost as quickly.

Unfortunately, the Preston accident which was due to excessive speed on a faulty curve, frightened the public and the Companies so much that a deceleration took place and it took a long time to start speeding up again.

V-2. — **Long non-stop runs.** — Here two factors should be considered : the length factor, and the speed factor. They do not necessarily run together, because the necessary qualities for long non-stop high-speed runs are not always to be met with. In spite of that, here again the tendency has been one of constant progress.

The longest non-stop runs take place in the same countries as the highest speeds, England heading the list (over 640 km. or 400 miles), followed by France, Italy, Germany and Japan.

The longest pre-War French non-stop run was that from Paris to Thouars (326 km. = 202.6 miles) at the relatively low average speed of 76.7 km. (47.6 miles) an hour. It has since been restricted to Paris-Saumur only. Such curtailment is usual. Indeed, it is not easy to maintain non-stop runs in face of the pressure brought upon the Companies — and more so if the railways are State-owned — by intermediate towns, in view of getting the trains to stop there. A former General Manager of the *Grand Central Belge Ry.* had found a way out of the difficulty : he simply asked the Town Councils of the places concerned to guarantee, pecuniarily, that there would be a sufficient number of travellers to or from their town, to justify this extra stop whose cost was assessed at so much per day. They usually insisted no further. But this method has not, to our knowledge, been repeated elsewhere.

The danger lies in the fact that once a first stop is inserted, others follow in quick succession, until a new non-stop train becomes necessary. As soon as it runs, the game begins all over again.

The question of water and fuel supplies is of primary importance in long non-stop runs. It is only in England and on a few sections of the *French State Railways*, that Ramsbottom troughs are used (1).

(1) The enormous summer non-stop runs to Edinburgh are only possible owing to the provision along the *East Coast Route* of six sets of troughs which enable the locomotives to add 5 000 gallons of water to the 5 000 they started with from King's Cross. Relief crews are carried and change over half way.

On the Japanese 3 ft.-6 in. gauge lines, as long a non-stop run as 300 km. (186 miles) has taken place but this was only possible by adding a tank wagon immediately behind the tender.

TABLE 33.

LONGEST NON-STOP RUNS.

In *italics* : Seasonal runs or runs subsequently suppressed.

COMPANY OR ADMINISTRATION.	RUN.	Distance Km.	Distance Miles.	Time of departure at	Time spent.	Speed Km./h.	Speed Miles/h
1. GREAT BRITAIN.							
London Midland & Scottish Ry.	*London (Euston)-Glasgow* (1).	*646.1*	*401.5*				
	Carlisle-London (Euston).	481.2	299.0	12.11 noon	5 34	86.4	53.7
	London (Euston)-Holyhead.	424.5	263.6	12.27 noon	5.12	81.6	50.7
	Glasgow-Crewe.	469.6	291.8	10.32 a. m.	6.18	74.5	46.3
London & North Eastern Ry .	*London (King's Cross)-Edinburgh* (1).	637.9	392.7	10.0 a. m.	7.30	84.3	52.4
	London *(King's Cross)-York.*	302.6	188.2	11.50 a. m.	3.15	93.3	57.4
Great Western Ry	*London (Padd.)-Newquay* (3).	*450.8*	*281.0*	*10.40 a. m.*	*6.05*	*74.3*	*46.2*
	London (Padd.)-Plymouth (2).	*363.2*	*225.7*	*10.30 noon*	*3.57*	*92.7*	*57.6*
	London (Padd.)-Torquay (2).	*322.4*	*199.7*	12.0 noon	*3.35*	*90.4*	*56.2*
	London (Padd.)-Exeter.	279.6	173.7	12.0 a. m.	2.50	98.7	61.3
Southern Ry	London (Waterloo)-Bournemouth.	173 8	108.0	4.30 p. m.	2.00	86.9	54.0
2. FRANCE.							
Nord	Paris-Liége.	367	228.1	10.10 a. m.	3.50	95.7	59.4
	Paris-Dunkirk (4).	*312*	*193.9*	*R6.40 a. m.*	*3.20*	*93.6*	*58.2*
	Paris-Brussels (Midi).	311	193.2	11.25 a. m.	3.15	95.7	59.4
	Paris-Calais (Maritime) (5).	299	180.8	12.0 noon	3.10	94.4	58.7
Est	Paris-Nancy (Strasbourg).	353	219.4	5 46 p. m.	3.51	91.7	56.9
State	Paris (Montparnasse)-Saumur.	286	177.7	12.10 noon	3.30	81.7	50.7
Paris-Orleans	Paris-Vierzon.	204	124.5	7.20 p. m.	2.15	90.7	56.3
P. L. M.	(Paris) Dijon-Lyons.	197	122.5	12.43 noon	2.14	88.2	54.8
Alsace-Lorraine	(Basle) Strasbourg-Metz (Bruss.)	159	99.0	10.50 a. m.	1.32	103.7	64.4
Midi.	Bordeaux-Dax.	148	91.9	5.22 p. m.	1.37	91.5	56.8

(1) Run in summer alone. At this period the train is divided up and one of the sections occasionally makes the very long non-stop. — (2) In Summer only. — (3) On Saturdays, — Summer only. — (4) This run has been suppressed. — (5) The morning train, which stops at Etaples, is 5 minutes faster.

COMPANY OR ADMINISTRATION.	RUN.	Distance Km.	Distance Miles.	Time of départure at	Time spent.	Speed Km./h.	Speed Miles/h.
3. OTHER COUNTRIES.							
ITALY. — State	Livorno-Rome.	316	196 3	3.6 p. m.	4.04	77.7	48.3
	Rome-Florence (1 condit. stop).	316	196.3	2.15 p. m.	4.19	73.2	45.5
GERMANY. — Reichsbahn. .	(Munich) Nurnberg-Halle (Berlin).	314	195.1	2.36 p. m.	4.05	77.5	48.1
JAPAN. — State	*(Tokio) Kozu-Nagoya (Kobe)* (6).	*300*	*186.4*				
PORTUGAL. — Portuguese Railways.	Pampilhosa-Lisbon (Rocio).	239	148.5	1 32 p. m.	3.08	76 3	47.4
CANADIAN National . . .	Rivers-Melville.	220.4	137.0	2.20 p. m.	3.35	61.5	38.2
Do. Pacific	Montreal (West) -Smiths Falls.	199.5	124.0	3.41 p. m.	1.49	109.9	68.0
HUNGARY. — State. . . .	Budapest (Keteli)-Hegyeshalom.	196	118.5	7.35 a. m.	2.36	75.4	46.8
AUSTRIA. — Federal Rys. .	Vienna (West)-Linz.	189	117.5	12.10 noon	2.27	77.2	47.9
POLAND. — State	(Warsaw) Kutno-Poznan.	178	110.6	2.34 p. m.	2.30	71.2	44 2
BELGIUM. — Nation. Ry. Co.	(Brussels) Namur-Luxemb.	164	101.9	2.49 p. m.	2 19	70.8	44.0
CZECHOSLOVAKIA. — State.	M. Ceska-Prague.	164	101.9	2.54 p. m.	2.15	72 9	45.4
SPAIN. — State	Madrid (Atocha)-Alcazar.	149	94.6	10.40 p. m.	2.14	66.7	41.4
	Saragossa-Fabara (Barcelona).	130	80.8	2.47 a. m.	1.56	67.2	41.7
SWITZERLAND. — Federal Rys.	Bellinzona-Arth-Goldau (Lucerne).	141	87.6	5.17 p. m.	2.16	62.2	38.6
Do. Rhætic Rys.	Samaden-Coire (6).	127	79.0	8.14 p. m.	2.16	56.0	34.8
HOLLAND. — Netherl. Rys.	Flushing-Boxtel.	138	85.8	6.15 p. m.	1.45	78.8	49.0
RUMANIA. — State. . . .	(Bucarest) Brasov-Sighisoara.	128	79.6	8.34 p. m.	1.55	66.8	30.4

) Metre-gauge lines. The Japanese run was made without stop thanks to the use of a tank-wagon behind the tender. oday an intermediate stop has been introduced.

In addition, the locomotive's feed water heaters economise a certain amount of water and enable the locomotive to travel further without replenishing its tanks. The long runs of the *Nord* and the *Est* would not be possible were it not for this device.

Non-stop runs have been lengthened continuously though there has occasionally been a set back in the speed at which they were run, partly owing to the fact that the longer the run, the more chance there is of its comprising sections with service or permanent way slacks. The following table has been prepared by the Rev. Reginal B. Fellows :

TABLE 34.

CHRONOLOGICAL TABLE OF THE LONGEST ENGLISH NON-STOP RUNS.

DATE (Year).	COMPANY.	ROUTE.	Distance		Time spent.	Speed.	
			Miles.	Km.		Miles/h.	Km./h.
1845	GW.	Paddington-Didcot	52 8	84.9	1 h. 8	46.6	75.0
1867	LNW.	Euston-Rugby	82.7	133.1	1 h. 56	42.8	68.9
1868	Mid.	Kentish Town-Leicester . .	97.5	156 9	2 h. 14	42.6	68.6
1878	GN.	King's Cross-Grantham. . .	105.5	169.8	2 h. 10	48.6	78.2
1885	NE.	Newcastle-Edinburgh . . .	124.5	200.3	2 h. 55	42.6	68.6
1895	LNW.	Euston-Crewe	158.2	254.6	3 h. 00	52.7	84.8
1897	GW.	Paddington-Exeter	193.6	311.6	3 h. 43	52.0	83.7
1904	GW.	Paddington-Plymouth . . .	245.6	395.2	4 h. 25	55.5	89.3
1928	LNE.	King's Cross-Edinburgh . .	392.7	632	8 h. 15	47.6	76.6

For certain very long runs, there are *service stops* which are not shown on the timetable, either for refuelling or, as in Italy, for changing the locomotive.

(To be continued.)

[621. 131 .3 (.44)]

The new dynamometer cars of the French Railways,

by P. PLACE,

Engineer, Office central d'Études de matériel de chemins de fer, Paris.

(*Revue Générale des Chemins de fer.*)

For making the necessary tests in connection with the design and development of their rolling stock, the French Railways up to the present time only possessed dynamometer cars which were of old design and did not meet present-day requirements.

The O. C. E. M. (Office central d'Etudes de Matériel de chemins de fer) was instructed to design more up to date dynamometer cars for joint use by the main line railways.

These vehicles, which are fitted with the best and latest equipment are described in this article, as is the way the different apparatus fitted function.

The O. C. E. M. designed and arranged for the construction of four dynamometer cars for the needs of the French Railways.

The cars are all-metal bogie vehicles of the new O. C. E. M. type (1) (fig. 1). They are all alike in their general layout, shown in figure 2.

Each car has :

1. a large room in which the apparatus are arranged;

Fig. 1. — One of the four new dynamometer cars.

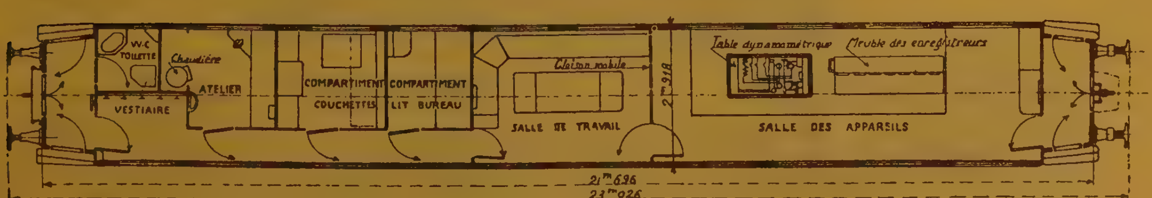


Fig. 2. — Diagram of one of the dynamometer cars.

Explanation of French terms:

Vestiaire = Cloakroom. — Tôilette = Lavatory. — Chaudière = Boiler. — Atelier = Workshop. — Compartiment = Compartment. — Couchettes = Bunks. — Lit-bureau = Desk-bed. — Salle de travail = Office. Cloison mobile = Foldable partition. — Salle des appareils = Room containing the apparatus. — Table dynamométrique = Instrument table. — Meuble des enregistreurs = Recording instrument board.

(1) *Revue Générale*, December 1931.

2. an office separated from the instrument room by a folding partition;

3. a compartment for the official in charge of the tests, fitted with a combined desk and bed;

4. a compartment for the staff with a sleeping bunk (two in some of the cars);

5. a workshop;

6. a lavatory.

The car is heated by thermo-syphon, or direct steam heating and is fitted with a through electric heating main.

It is fitted with ordinary carriage electric lighting; as an experiment one of the cars has a small petrol motor under the frame for recharging the batteries in the event of the car standing a long time anywhere.

I. — Measuring apparatus.

The four cars are each fitted with a dynamometer and instrument table, as well as the necessary instruments for recording temperatures, pressures, etc...

In addition, cars Nos. I and II are fitted for brake tests, whereas the two other cars, Nos. III and IV, are fitted with apparatus for recording the relative movements of the bodies and bogies or any other parts.

Dynamometer and instrument table.

These apparatus were made by Messrs. Amsler of Schaffhausen. The dynamometer is hydraulic (fig. 3). — It consists of a drawbar hook, two buffers articulated to one another and to the drawbar

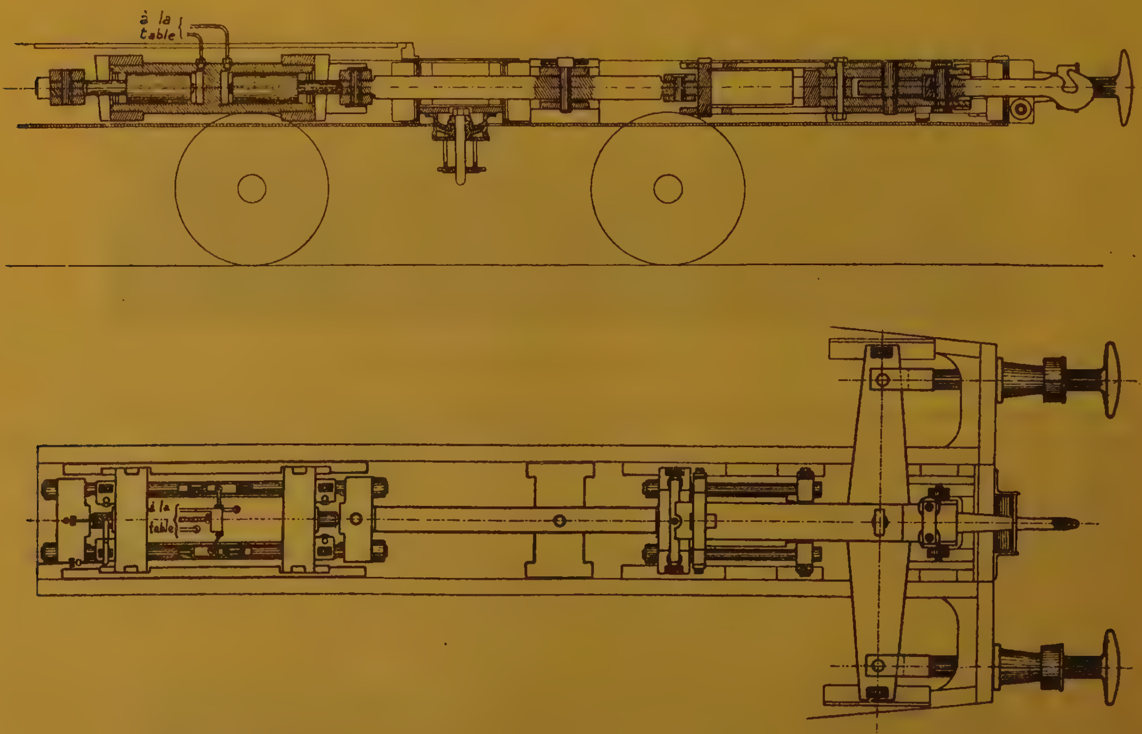


Fig. 3. — Drawing and buffing gear and press pot of hydraulic dynamometer.

hook by an equalising beam, a press pot with two opposed cylinders, one for working in pull, and the other in compression. The articulation of the buffers with the equaliser is intended to eliminate from the measurement the parasitic force due to the initial tightening up of the coupling.

The equipment in car No. I is designed to work normally under tractive or buffing efforts of up to 90 metric tons, but can stand, without permanent deformation, exceptional efforts of 140 tons.

The equipment of cars Nos. II, III and IV normally can stand efforts of up to 45 metric tons, and exceptionally up to 70 tons. Apart from this difference, the equipment of the four cars is identical, the instrument tables (fig. 4) being fitted with the same apparatus.

Recording the distance travelled. — The drive for moving the paper over the table as well as for recording the distances run is obtained by gear fitted to an unbraked wheel of the nearer bogie.

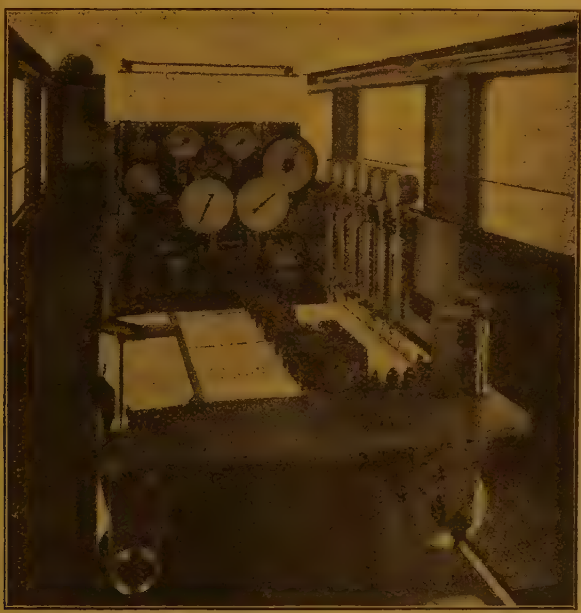


Fig. 4. — Instrument table.

In order to take into account the progressive wear of the tyres, three pairs of gears of different ratios are provided so that the wheel can be used without changing the tyres, until the original diameter has been reduced by 2 %. The maximum possible error in calculating the distance travelled is 0.33 to 0.34 %.

The recording paper can be advanced as desired, either proportionally to the time, or to the distance travelled, and in each case at three different speeds :

1 mm. 5 mm. 30 mm. per sec.
or
20 mm. 100 mm. or 600 mm. per km.

The method of advancing the paper and the speed can be changed while running without interrupting the recording.

Recording the efforts. — The equipment is at all times ready to record

either tractive or buffing efforts, these being measured by the displacement of the small piston of the hydraulic press forming the dynamometer. This small piston is balanced by a calibrated spring.

This recording can be done to three different scales, or degrees, by working on three pistons of different diameters which are always kept under load by the same spring. Only one valve has to be operated to change from one scale to another.

The total travel of the effort recording pen, which is 100 mm., corresponds according to the scale used to efforts of :

6, 15 or 90 metric tons for the car No. I,

6, 15 or 45 metric tons for the other cars.

Two gauges, graduated in metric tons, show at every moment, one the tractive effort exerted on the dynamometer, and the other the compression effort. Each of these gauges is fitted with a second and free finger which is pushed by the first or indicating finger in the direction of increasing efforts and remains in the position corresponding to the maximum effort exerted during a given run.

Recording the time. — A small electric motor driven off the 24-volt battery of the vehicle and fitted with a ball type-governor revolves at absolutely constant speed. It controls the working of all the measuring instruments of the table, the displacements of which have to be proportional to the time.

Recording the inertia and gravity forces. — These forces are measured by the deviations of an inertia pendulum whose axis of rotation is horizontal and at right angles to the symmetrical plane of the vehicle.

These forces are recorded together with the work they do.

Speed. Work of the tractive effort. Instantaneous power. Work done by the inertia and gravity forces. — The whole of these elements are determined by means of instruments on the well known Amsler ball system.

Speed.

The speed is both recorded and indicated. The record on the diagram paper can be at either of two scales : in one the total travel of the stylo corresponds to a speed of 75 km. (46.6 miles) an hour, and the other to that of 150 km. (93.2 miles) an hour.

The speed as determined by the Amsler instruments can be read off directly on a scale with two different graduations corresponding to the two previous scales.

In addition, the dynamometer car has been fitted with two different speed indicators, entirely independent one of the other, and of the Amsler equipment : one being a Teloc, and the other a Deuta, the Teloc recording as well as indicating the speed.

Work at the drawbar.

The work at the drawbar is registered on the paper. It is possible to record in kilogrammetres the work produced, either tractive or compression; the change-over from recording to the other is done by means of a reversing valve; the recording of the effort in compression was provided for brake trials.

Instantaneous power.

Recording the instantaneous power. — The apparatus giving the instantaneous power is fitted with two pairs of gear wheels, either of which can be inserted between the work counter and the indicator of the power developed. The provision of these two pairs of gears makes it possible to record to two different scales, and this for each of the three scales of sensitiveness of the effort recording devices.

An indicator repeats the values of the instantaneous power. Three adjustable double-faced gauges are graduated in

agreement with the six scales of sensitiveness to which the instantaneous power can be recorded.

Various records made on the dynamometer table.

Time record. — A clock fitted with electric contacts makes it possible to register automatically the time, minute by minute.

By means of the constant speed electric motor mentioned above, the time can be recorded at intervals or 2 seconds, 6 seconds, or 12 seconds.

Pens controlled by electro-magnets record the working of the driver's brake handle and that of the regulator. Additional pens are available for taking any other record desired.

Finally, the apparatus on the instrument table are completed in the four cars by distance indicators consisting of a vertical wire which moves 5 mm. per kilometre in front of a diagrammatical section of the line being run over.

A klaxon horn can be arranged to sound automatically every minute, five minutes, or ten minutes, or alternatively every 1, 5 and 10 kilometres, both in the dynamometer car and on the engine.

Apparatus for brake tests (Cars Nos. I and II). — The apparatus for making brake tests consists of a triangular brake beam fitted with dynamometer cylinders for arriving at the radial and tangential brake pressures on the blocks. These pressures are shown on two gauges fitted on the instrument table, and are recorded on the diagram. The air pressures in the main reservoir, the auxiliary reservoir and the train pipe as well as in the two brake cylinders are also indicated and recorded.

So as to be able to investigate the speed of propagation of the braking wave, electric contacts can be fitted on the train pipe; they are operated by the air in the train pipe and in turn control pens on the table.

In order to record the length of the braking distance from the time of the application to that at which the train is stopped, a counter graduated in metres is driven by one of the axles of the car. The meter is automatically brought into mesh by the electro-magnet when the driver moves his brake handle; after the train has been stopped, the meter is released by the man in charge of the car.

Recording relative movements (Cars Nos. III and IV). — It may be necessary to record certain relative movements between two parts of a carriage, such as those due to the variations of deflection of the bogie or bolster springs.

Transmission of the relative movement of the two parts in question to the pen which traces the movement on the table is by means of a fine metal cable attached to one of the parts; it is carried over a roller fixed to the other part whence it is continued to the instrument table which it crosses at right angles to the diagram. The cable carries a pen which traces the record of its movement on the diagram. It is finally attached to a long coiled spring which keeps it in tension. Eight such cables are provided in each car.

Recording data relating to the working of the locomotive.

Various recording pens are provided on the instrument table, connected to electro-magnets which can be put into action by operating any given fitting on the locomotive and thereby made to register the moment the fitting in question is operated; in this way, for example, the working of the regulator and of the driver's brake valve handle can be recorded.

The most valuable readings to be noted are, however, the temperatures and the pressures.

Temperatures. — Resistance pyrometers can be fitted on the locomotive at the various points at which it is desired

to measure the temperatures. The readings are transmitted to recorders in the dynamometer car.

The principle of these pyrometers is the following : to each temperature to which the pyrometer is subjected there corresponds, according to a known law, an electrical resistance of the platinum wire of which it is formed; this resistance is measured against a known resistance by means of a cross-coiled galvanometer. The galvanometer needle moves across a scale graduated in degrees.

There are four temperature recorders in each car, each including a galvanometer which is automatically connected every ten seconds in turn to six pyrometers. A given recorder, therefore, can register successively by the impression of points on the recording band of paper, the temperatures at six different positions. The points recorded corresponding to the six pyrometers being of six different colours, one colour per pyrometer, the record is in the form of six curves of different colours and so can be distinguished one from another.

Two of the recorders are specially allocated to the temperatures of the hot gases in the smoke box. They have each two scales, one reading from 100 to 300° C. (212 to 572° F.), and the other from 200 to 600° (392 to 1 112° F.). A switch is provided so that either scale can be used as desired.

A third temperature recorder is reserved for recording the temperature of the air or of the water. It has two scales, one 0 to 160° C. (320° F.), and the other 0 to 320° C. (608° F.).

A fourth recorder is reserved for the saturated and superheated steam temperatures; it has two scales, one 0 to 250° C. (482° F.), and the other 150 to 500° C. (302 to 932° F.).

Pressures. — The pressures (and the vacua) are measured and indicated by gauges on the locomotive. The indications given by these gauges are transmitted electrically to the dynamometer car; they are recorded by apparatus identical with that used for recording the temperatures.

The electrical transmitter of each gauge in principle consists of a resistance wound on a cylinder the axis of which is the same as that of the needle of the gauge. A contact on this needle moves on the cylinder and varies the resistance of the electrical transmission circuit. As with the temperatures, this resistance is compared with a known resistance value.

The recorder in the dynamometer car records the value of this resistance and consequently of the pressure or vacuum, as it records that of the pyrometer in the case of the temperatures.

Gauges are provided to read pressures of 0 to 1.5 hpz., 0 to 10 hpz., and 0 to 25 hpz. (0 to 21.8, 0 to 145, and 0 to 362 lb. per sq. inch).

The recorder, recording six curves, has three corresponding scales of measurement.

The gauges showing the vacua are of the diaphragm type. The readings are transmitted to the dynamometer car and recorded in the same way as those of the other gauges. Gauges are provided to read vacua of 0 to 500, 0 to 300, 0 to 200 and 0 to 100 mm. (0 to 19.7, 0 to 11.8, 0 to 7.8, and 0 to 3.9 inches) of water.

In the event of having to test high-pressure locomotives, gauges reading to 150 hpz (2 180 lb. per sq. inch), and a corresponding six-curve recorder have been provided and can be fitted in one of the dynamometer cars, either as an additional equipment or in place of one of the ordinary recorders, recording a maximum of 25 hpz. (362 lb. sq. inch).

Analysis of the smoke box gases. — Each car has apparatus for analysing the gases fed to it by a small suction pump and a pipe from the smoke box; this analyser is based on the difference of thermal conductivity of the different gases. The indications — content in CO^2 and $CO + H^2$ are automatically recorded.

We found when testing at the works

of the makers, Messrs. Hartmann & Braun, of Francfort, that the apparatus could give exact results but that it required rather delicate adjustment. We therefore decided that the information it gave could only be used for controlling the firing An Orsat apparatus was subsequently provided so that a more accurate analysis of the gases could be made.

All the temperature and pressure recorders and analysers are brought together into one board (fig. 5).

Meter for measuring steam used for the train heating. — A steam meter, inserted in the main steam heating pipe running under the dynamometer car, is used to measure the steam used in heating the train. This meter will record a flow of up to 2 500 kgr. (5 510 lb.) of steam per hour with a maximum temperature of 450° C. (842° F.) and a pressure varying between 3.75 and 9 kgr./cm² (53.3 and 128 lb. per sq. inch).

Fig. 5. — Instrument room with, in the foreground, the board carrying the instruments for recording temperatures, pressures, etc.

Locomotive feed water meter. — In conjunction with the dynamometer cars, water meters on the engine are used. These meters are volumetric meters of the piston type designed for a normal flow of 18 m³ (3 962 Br. gallons) — [maximum flow : 27 m³ = 5 942 Br. gallons] against a pressure of 30 kgr./cm² (427 lb. per sq. inch), and a water temperature as high as 235° C. (455° F.).

These meters are read off directly by reading revolution counters graduated in litres mounted on the apparatus itself; they are also repeated in the car.

Special equipment. — A telephone is provided between the engine and the car for dual way communication, both by combined phone and by loud speaker with valve amplifier.

Periscopes, one at the end of the instrument room, platform side, and the other at the extreme opposite end of the office, have been fitted so that the signals

and the inside of the cab can be seen. These fittings take up little room and have saved the space generally given over to the look-out.

Electric connections between the locomotive and the dynamometer car. — A large number of electric leads had to be arranged between the locomotive and the dynamometer car for the pyrometers, pressure and vacua gauges, telephones, and the klaxon circuits and for recording the operation of the locomotive fittings.

90 wires 50 m. (170 feet) long have been provided : only some of them are used in the beginning, the others being in reserve for new equipment or to replace any broken wires.

In order to find space for such a number of leads very flexible cables had to be specially manufactured, so that they could be rolled up round a small-diameter cylinder.

Each cable has 18 leads; each lead formed of five wires, not plaited, has a diameter of 1.5 mm. (0.059 inch) and its insulation is 600 Ω per km. (960 meghoms per mile). The whole of the cable of 18 leads has an outside diameter of 22 mm. (7/8 inch) and can be rolled up on a cylinder of 200 mm. (7 7/8 inches) diameter. Five similar cables have been provided.

Each cable is rolled up on a drum stored in a container carried under the car.

The wires are connected by bolts, nuts, check nuts, or welding : at one end, to the detector apparatus on the engine and at the other to the recorders in the car.

The cables have to be separated sometimes so that the locomotive can be uncoupled from the dynamometer car. Each of the sections of the cables in question is therefore fitted with a half coupling.

Owing to the very low strength of the currents in connection with the indicators, the least defect in the insulation or contact might introduce appreciable errors.

The special conditions required in the present case for the couplings were the following :

— quick operation;

— constancy of the electrical resistance during a test, in spite of vibration;

— constant electrical resistance as regards time, in spite of the couplings becoming distorted;

— good protection of the contacts against dust and damp.

As satisfactory couplings could not be found on the market, we designed and completed a coupling (figs. 6 and 7) in which the pressure at the contact is assured by a screw.

Each of the two ends to be connected of a given wire 1 or 2 is connected to a copper terminal 3 or 4 by welding or by a bolt with nut and check nut. The terminals of one half coupling are threaded on an insulating tube 5 which allows them a little play in all directions (fig. 8).

The coupling together of the two half couplings brings into contact on one of their faces the pairs of terminals 3 and 4 of a given wire. There is therefore a pile of these pairs separated from one another by the insulating blocks 6 and 7. The whole is tightened up by the screws 8 like a book press.

The two half couplings make a tight joint with one another and are held together by a stirrup (figs. 6 and 7).

The efficiency of the coupling is due to the faces of the copper terminals being carefully fitted and these terminals and the insulating blocks having play in all directions.

In the actual couplings the 18 terminals of a half coupling corresponding to the 18 wires of a cable are arranged in two parallel sets of 9. After assembling the half couplings there are only two screws to tighten up.

Leak compensating pump for the dynamometer. — The press pot of the dynamometer consists of a block of steel out of which are bored the two cylinders, one for dealing with tractive efforts and the other with compressive efforts. In order to reduce friction, the pistons working in these cylinders are fitted with neither rings nor packings. The oil contained in them slowly leaks out so that unless special precautions were taken, a piston, after a sufficiently long time, might come into contact with the bottom of the cylinder.

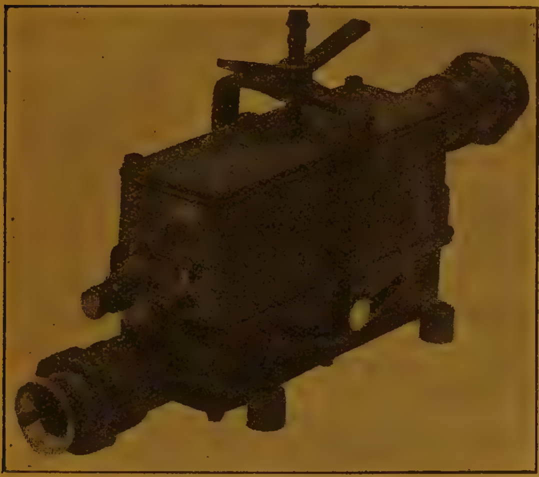


Fig. 6. — Coupling.

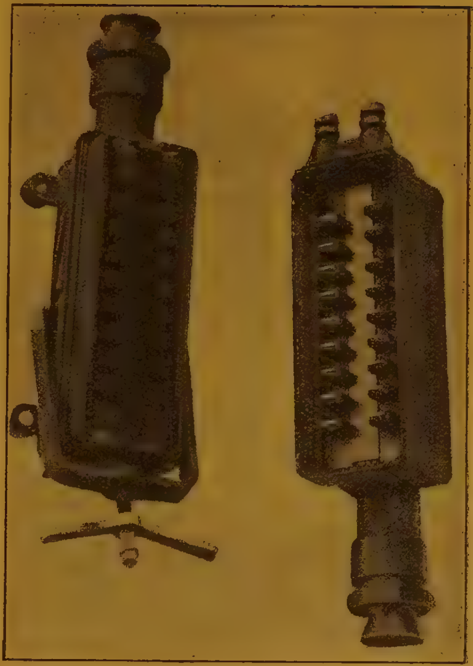


Fig. 7. — View of the two half couplings ready for coupling up.

Messrs. Amsler had used up to now a method of making up these losses which acted automatically as soon as the load on the drawbar changed in direction, by falling to zero. In ordinary road trials this method met the requirements as it is unusual for the tractive effort to continue for several hours; besides the leakage is quite small; when making tests at the makers' works the piston of the dynamometer of car No. 1, loaded to 50 tons, was only driven in 5 mm. (3/16 inch) in 30 minutes; as the available travel is 60 mm. (2 3/8 inches), six hours ordinary running can be counted upon.

Nonetheless, for the test plant under construction at Vitry, where there is a single traction dynamometer on which the ordinary compensation system could not be used, another method had to be employed and this, as a precaution, was applied to the four dynamometer cars. A piston pump running constantly during the trial can pump oil into the cylinders against any pressure there may be in them. When the piston has gone into its cylinder a certain distance, which can be set by means of an adjustable stop, the pump sends oil into the cylinders. As soon as the leakage has been made up and the piston restored to its proper working position, the pump is short circuited.

As we shall see later on in Table III, the working of the pump does not cause

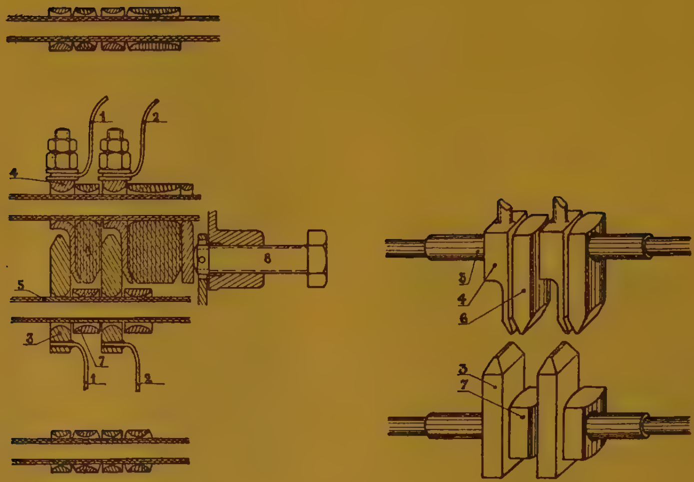


Fig. 8. — Details of coupling.

any appreciable rise in pressure in the dynamometer cylinder and this is due to the very small amount of friction of the piston in the cylinder.

II. — Accuracy of the measurements.

It was essential to know what approximation we could count upon as regards the measurements of the various items. We gave the builders of the apparatus minimum conditions as to accuracy; tests made at the works proved that the accuracy was better than that specified.

Tables I and II give the conditions specified and the results of the inspection tests on the apparatus of one of the dynamometer cars.

It was also necessary to be satisfied that the degree of accuracy obtained when the car was new would be maintained in service.

In order to be able to check, when desired, quickly and with certainty the accuracy of the recording of the tractive and compressive efforts, an arrangement using a calibrating box calibrated itself by direct loading (weights) was permanently attached to the drawbar. These calibrating boxes, which are very accurate, were prepared for the official calibration of the machines for testing metals.

Amsler dynamometer apparatus. Tolerances.

Tractive or compressive efforts.

	Maximum difference allowed.
Difference D_1 between the pressure of the oil in the pipe coupling acting on the measuring piston and the calculated pressure for a definitely known force (a weight) acting on the dynamometer piston (error possibly arising from the friction of the dynamometer pistons properly speaking)	$D_1 \leqslant \pm 1\,\%$
Difference D_2 between the effort recorded by the pen and the calculated effort for an exactly known oil pressure acting on the measuring pistons (error possibly due to the imperfection of the measuring spring and to the friction of the measuring pistons)	$D_2 \leqslant \pm 1\,\%$
Difference between the effort E_e recorded by the pen and the actual effort E_r accurately known (weights) acting on the dynamometer piston (sum of the above differences $E_r - E_e = D_1 + D_2$.	$E_r - E_e \leqslant \pm 2\,\%$

Speed. — Difference between the recorded speed V_e and the speed V_r calculated from the time taken to run a given distance. The length of the distance run is known without any error from the length of paper unwound (error possibly due to the differential ball-type instrument) . . . . . . $V_r - V_e \leqslant \pm 1.5\ ^0/_0$

Work at the drawbar hook. — Difference between the recorded work T_e and the work T_a corresponding to the effort recorded by the pen over a run, the length of which is known accurately by the unwinding of the paper (± 1.5 % which may be due to the ball-type integrating apparatus). . . . . . . $T_e - T_a \leqslant \pm 1.5\ ^0/_0$

Difference between the recorded work T_e and the real work T_r (± 3.5 % of which ± 2 % may result from errors on the efforts ($E_r - E_e$) and ± 1.5 % from the integrator ($T_e - T_a$). . . . . $T_r - T_e \leqslant \pm 3\ 5\ ^0/_0$

Instantaneous power at the drawbar hook.

Difference between the recorded instantaneous power P_e and the instantaneous power P_a corresponding to the effort indicated by the pen on a run known accurately by the unwinding of the paper and during a period of time accurately known (± 3 %, of which 1.5 % may be due to the ball-type integrator for the work $T_e - T_a$ and 1.5 % from the ball-type power differentiator) . . . . $P_e - P_a \leqslant \pm 3\ ^0/_0$

Difference between the recorded instantaneous power P_e and the actual power P_r (± 5 %, of which ± 2 % may be due to errors in the efforts $E_r - E_e$, and ± 3 % in the two ball-type apparatus for the work and for the power $P_e - P_a$) . . . . $P_r - P_e \leqslant \pm 5\ ^0/_0$

Work due to the inertia forces. — Difference between the work recorded and the work corresponding to an inclination of the inertia pendulum given *a priori*, and corresponding to a known inertia effort (± 1.5 %, error which may be due to the ball-type integrator) . . . . ± 1.5 %

Difference between the work recorded and the actual work (± 3.5 %, of which ± 2 % may be due to the error as regards the inertia forces and ± 1.5 % in the integrator) . . . . $I_r - I_e \leqslant \pm 3.5\ ^0/_0$

Tables I and II compare, for one of the sets of equipment, the specified approximations and the much better figures obtained during the inspection tests.

TABLE I.

Amsler equipment.

Approximation obtained when recording the efforts.

1. Error due to the friction of the dynamometer piston.

Test loads in metric tons.	...	5	10	20	30	40	45
	Approximation specified in $^0/_0$ D_1.	Approximation obtained in $^0/_0$.					
Tractive effort	± 1	−0.02	−0.13	+0.12	+0.11	+0.21	+0.21
Compressive effort . .	± 1	−0.05	−0.13	+0.08	+0.11	+0.13	+0.20

2. Error due to the imperfection of the measuring spring and to the friction of the recording pistons.

Working scale	...	6 t.			15 t.			45 t.		
Test load in metric tons	...	3.6	4.8	6	9	12	15	27	36	45
	Approximation specified in $^0/_0$ D_2.	Approximation obtained in $^0/_0$.								
Tractive effort	± 1	+0.6	+0.25	0	+0.5	−0.12	+0.1	−0.75	+0.12	−0.5
Compressive effort . .	± 1	+0.36	+0.09	+0.1	+0.25	0	−0.2	+0.35	+0.8	+0.1

TABLE II.

Approximations obtained when recording the various magnitudes other than those of the efforts (test for a 22.5 metric-ton tractive effort).

	Trial conditions.			
Calculated speed in km./h. . .	...	30.09	60.70	99.88
Inclination of the inertia pendulum to the vertical. . . .	...	1/10	1/10	1/10
	Approximation specified %.	Approximation obtained %.		
Mean *speed*.	$V_r - V_e \leqslant \pm 1.5$ %	$+ 0.68$ %	$- 0.69$ %	$+ 0.18$ %
Work at the drawbar hook . .	$T_r - T_e \leqslant \pm 3.5$ %	$+ 1.6$ %	$+ 1.67$ %	$+ 1.55$ %
Power at the drawbar hook. .	$P_r - P_e \leqslant \pm 5$ %	$+ 1.08$ %	$+ 2.89$ %	$+ 2.56$ %
Work due to the inertia forces.	$I_r - I_e \leqslant \pm 3.5$ %	$- 0.49$ %	$- 0.38$ %	$- 1.40$ %

TABLE III.

Comparison between the pressures set up in the dynamometer cylinders by a constant load (weights) with or without the leakage make-up pump working.

LOAD.	Pressures measured.		
	Pump not acting kgr./cm².	The pump just makes up the leakage of the piston without causing the latter to move. kgr./cm².	The pump is stopped. kgr./cm².
20 metric tons	75.200	75.450	75.300
40 metric tons	150.700	150.900	150.600
50 metric tons	188.300	188 300	188.300

Temperature recorders.

The minimum approximation to which a known temperature is recorded is ± 1 % of the maximum temperature of the scale to which the record is made.

The control of the thermometers is carried out in a bottle of oil or salpetre, the temperature of which is measured by means of a calibrated mercury thermometer.

The tests at the makers' works of the dynamometer car apparatus showed errors of 2° to 3° C. for the scale used, the maximum of which was either 250° C. or 500° C.

Smoke box gas analyser.

The approximation to which the CO^2 and $CO + H^2$ of a gas whose combination was determined by the Orsat apparatus is ± 0.2 % and ± 0.5 % respectively of the content in CO^2 and $CO - H^2$. These figures have been confirmed in practice.

Water meters.

The approximations with which a weighed quantity of water is recorded is ± 0.5 % for all rates of discharge between one tenth and the normal discharge of the meter.

During the inspection tests at the makers' works we found that the above allowed error was not reached but was found to be less than 1/1 000th.

[621. 132.5 (.73) & 621. 134.3 (.73)]

High-pressure triple-expansion locomotive.

Four-cylinder triple-expansion locomotive using steam at 500 lb. per sq. inch. pressure, Delaware and Hudson Railroad.

(*The Railway Gazette.*)

Fig. 1.

In the issue of the *Railway Gazette*, dated 12 August 1932, we made brief reference to the constructional features of a further high-pressure locomotive for the Delaware & Hudson Railroad, and are now able to illustrate and give a more detailed description of its principal features. The engine is the fourth to use high-pressure steam on the Delaware & Hudson Railroad, and, like the former examples, it is intended for heavy freight service. In general, the design follows that of the first locomotive, No. 1400, of 1924, the well-known *Horatio Allen* (1), and of those subsequently built, namely the *John B. Jervis* (2), No. 1401, and *James Archbald* (3), No. 1402, of 1927 and 1930 respectively, but whereas all these had the 2-8-0 wheel arrangement with cross-compound cylinders, the new engine is of the 4-8-0 type and has four cylinders arranged for triple-expansion working. Of these, the two low-pressure cylinders are located at the bogie centre outside the frames at the front end, and drive the second pair of coupled wheels. The high-pressure cylinder is mounted at the rear of the locomotive below the footplate on the righ-hand side, whilst the intermediate pressure cylinder occupies a similar position on the oppositie, *i.e.*, the left-hand side of the engine, and these likewise drive the second pair of coupled wheels.

Steam distribution to the cylinders is effected by means of poppet valves actuated by rotating cams. The « R.C. » poppet-valve gear is used, and this was designed and supplied to the makers by Société d'Exploitation des Procédés Dabeg, Paris. The high-pressure and intermediate-pressure cylinders are each fitted with four poppet valves, two side by side at each end of the cylinders, one for admission and the other for exhaust. For the low-pressure cylinders the arrangement is the same, except that four exhaust valves are fitted, two at

(1) Cf. *Bulletin of the Railway Congress*, February 1926, p. 130.

(2) Cf. *Bulletin of the Railway Congress*, June 1927, p. 552.

(3) Cf. *Bulletin of the Railway Congress*, July 1930, p. 1699, and May 1931, p. 380.

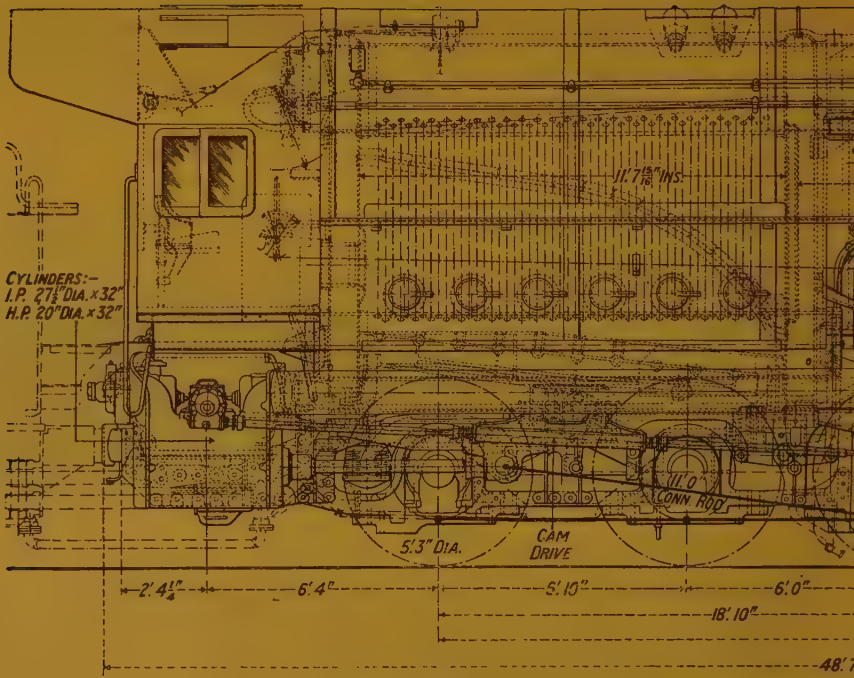
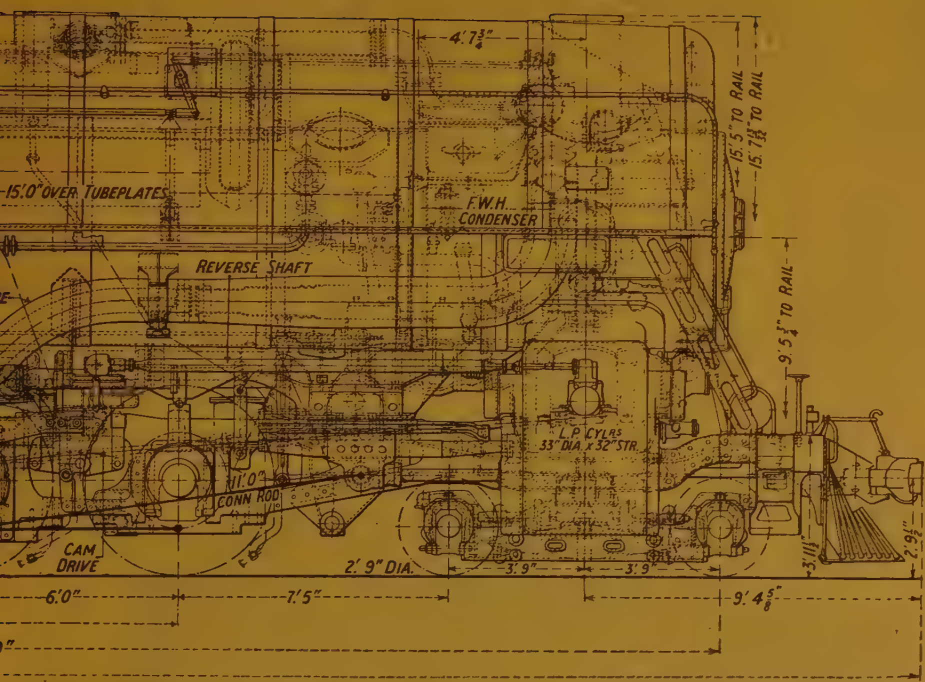


Fig. 3. — General arrangement drawing of

either end of each cylinder. The valves are horizontally arranged and are operated by two cam shafts, one for each pair of cylinders. The cam shaft drive, on each side of the engine, is effected by means of return cranks fitted to the main crank pin and driving gears disposed in casings mounted on a bracket casting outside the main driving wheels. Specially designed connections between the return crank arms and the gears permit of the flexibility necessary for the relative movement between the driving wheels and the gearbox fixed to the frames. The main driving shafts between the return crank gears and the cam shafts are fully universal and are each in two lengths, the centre part being carried in an intermediate bearing bracket supported on the engine main frames. Reversal and alteration of cut-off is effected by power-reversing gear.

Each pair of cylinders is cast of steel in one piece, and the cylinder barrels are fitted with cast-iron liners. The steam supply to the high-pressure cylinder is taken from a throttle valve fitted outside the front of the engine, the outside steam pipe being shown in the photographic reproduction of the engine, whilst the exhaust steam from the intermediate cylinder passes to the L.P. cylinders at the leading end by means of a single pipe running along the longitudinal centre line of the locomotive just above the driving axles. The steam chest for the intermediate cylinder is fitted with an automatic feed valve for supplying steam at starting, and the low-pressure cylinders are fitted with the well-known Mellin starting and intercepting valve, supplemented by an accelerator valve.

The general design of the boiler and superheater follows that used in the previous locomotives mentioned, with



nsion locomotive, Delaware and Hudson Railroad.

slight detail modifications. The total evaporative heating surface is 3 351 sq. feet and the superheater adds 1 076 sq. feet. The grate area is 75.8 sq. feet. A special design of Dabeg feed-water heater and pump is used, and the pump is mechanically driven from a connection on the crosshead of the left-hand side low-pressure cylinder. The coupled wheels have a diameter of 5 ft. 3 in. and the main journals have roller bearings. The diameter of the wheels for the leading bogie is 2 ft. 9 in.; the total engine wheelbase is 33 ft. 9 in. and that of the coupled wheels 18 ft. 10 in. At starting in simple gear the estimated tractive effort is 90 000 lb. when the adhesion factor is 3.48, and the maximum rate of tractive effort when working triple expansion is 75 000 lb., the factor of adhesion being 4.17. The engine weighs, in working order, 170 1/2 tons, and with the tender totals 293 tons. The latter has a Bethlehem six-coupled booster taking steam at 500 lb. pressure, and this adds a further tractive effort of 18 000 lb., so that the maximum tractive effort available for starting heavy trains amounts to 108 000 lb. The tender capacity is moderate for so large a locomotive, but as high efficiency is expected, space for 15 1/2 tons of coal and 11 700 Imp. gallons of water is considered sufficient. The weight of the tender in working order is 122 tons.

This locomotive has been constructed to the requirements of Mr. G. S. Edmonds, Superintendent of Motive Power, Delaware & Hudson Railroad, and Mr. J. E. Muhlfeld, Consulting Engineer to the Company. It was built at the Schenectady Works of the American Locomotive Company. The locomotive is named *L. F. Loree* after the chairman of the railway company.

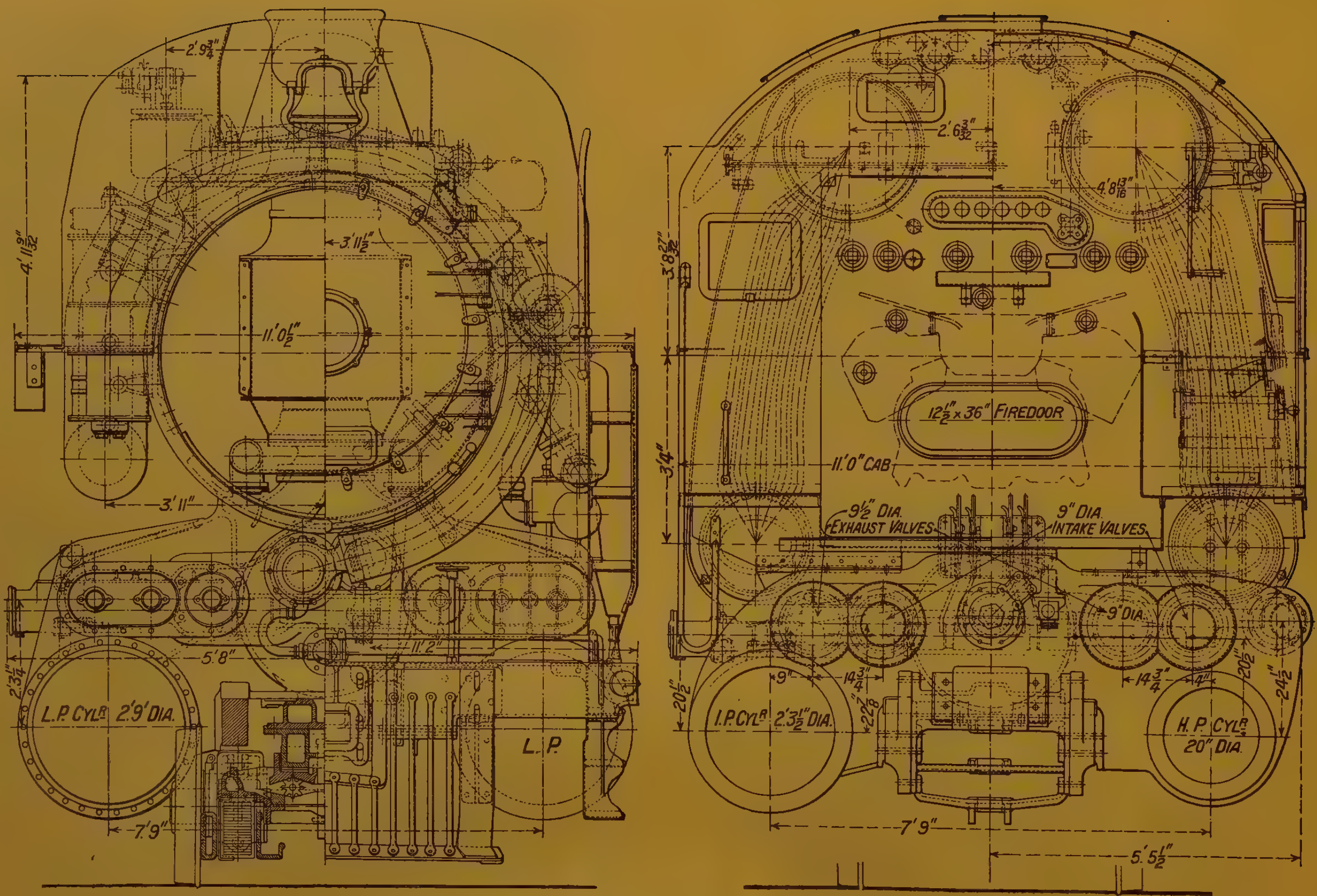


Fig. 2. — Sectional and end elevations.

[625 .23 (0 & 625. 232 (.73)]

Pullman aluminum cars mark new era in car construction.

(*Railway Age.*)

A method of saving approximately 50 % in passenger-car weight, without the sacrifice of essential strength or carrying capacity, is the latest Pullman contribution to better railroading. The suggestion is made in the form of two all-aluminum cars, exhibited at the Century of Progress Exposition, Chicago. The larger of these cars is an 84-foot observation-room car, designed jointly by the Pullman Company and the Pullman Car & Manufacturing Corp., and intended for operation in regular main-line passenger-train service. The other car is a 79-foot observation coach, designed by the Pullman Car & Manufacturing Corporation for main-line service and particularly adapted, because of its light weight, to use as a motor-train trailer.

Fig. 1. — Aluminum observation coach of the Pullman Car & Manufacturing Corporation.

Both cars, built at the Pullman Car Works, Chicago, are outstanding examples of engineering design and metal craftsmanship. Of striking beauty inside and out, these cars are completely appointed; equipped with the improved Pullman Car & Manufacturing Corporation air-conditioning system; especially constructed to exclude dirt and dampen noise and vibration at all speeds, and provided with modified streamline observation ends to reduce air resistance. The cars constitute, in effect, the third great evolution in Pullman construction: Namely, wood, in 1859; steel, in 1907; and lighter cars of equivalent strength (in this instance, embodying aluminum construction) in 1933.

The primary objective of the last step

mentioned is to co-operate with the railroads in developing light-weight passenger equipment which, in accordance with modern demands, will be safe to operate at high speeds; possess comfort and aesthetic features, assuring maximum passenger appeal; and, therefore, help to build up passenger traffic and earnings. Important attendant advantages anticipated as a result of the use of lighter equipment include appreciable reductions in several items of operating expense, as well as reduced track and equipment maintenance.

The aluminum observation-room car, which was the subject of a comprehensive illustrated address by Peter Parke, chief engineer of the Pullman Company, before the 19 May meeting of the New York Railroad Club, will be described in a subsequent issue of the *Railway Age*.

Principal features of the aluminum observation coach.

The aluminum observation coach, which is a product of the Pullman Car & Manufacturing Corporation, has a seating capacity of 50 and weighs 73 880 lb., of which 6 880 lb. constitutes the weight of the air-conditioning equipment. While no car of identical design and capacity has ever been built of steel, and an exact comparison of weights is, therefore, impossible, it is estimated that a saving of at least 50 % in weight is effected by the present construction.

Fig. 2. — The four-wheel fabricated aluminum truck.

General dimensions and weights of the Pullman Car and Manufacturing Corporation aluminum observation coach.

Length over body end sills.	73 ft. 5 1/2 in.
Length between truck centers.	56 ft. 0 in.
Length over buffer uncoupled.	78 ft. 10 1/8 in.
Width over side posts . . .	9 ft. 9 3/8 in.
Width overall at eaves . . .	10 ft. 1 in.
Height, top of rail to bottom of side sills	3 ft. 5 1/2 in.
Height, track to top of roof at center	13 ft. 1 in.
Distance, end sill to buffer beam (vestibule end). . .	2 ft. 9 in.
Seating capacity	50
Total weight of car (excluding air-conditioning equipment)	67 000 lb.
Weight of air-conditioning equipment)	6 880 lb.
Weights (including air-conditioning equipment):	
Car body	55 880 lb.
Trucks	18 000 lb.
Total. . .	73 880 lb.

Strong aluminum alloys, furnished by the Aluminium Company of America and having various physical properties, dependent upon the needs, are used for all parts of the car struture except the wheels, axles, springs, brake shoes and certain other parts subject to wear, which are all of steel or steel-faced for

greater durability. In the car design due account has been taken of the greater deflection of aluminum, in the ratio of 3 to 1 to that of steel, and its higher co-efficient of expansion, which is twice that of steel. The finished car strikingly illustrates how these particular problems can be solved and an outstanding reduction in weight secured without sacrificing strength or safety.

While design problems in this initial car were somewhat accentuated by the use of aluminum, the actual construction of the car was facilitated by the greater adaptability of this material to fabrication, particularly through the use of extruded shapes and sections. Full advantage is taken of standard rolled-aluminum plates and shapes; aluminum castings are used, where necessary; pressed aluminum sections are extensively employed, these sections being formed cold by more of a rolling than a pressing process which conserves both metal thickness and physical characteristics; but principal interest centers about the use of special extruded aluminum shapes, formed by forcing aluminum through metal dies which give it box-section and other shapes impossible to reproduce in steel up to the present time.

The extruded aluminium shapes are, to all practical purposes, perfectly straight, smooth and accurate, and their use reduces substantially the number of individual parts required, eliminates many rivets, saves overlapping joints, and generally permits an interlocking design which contributes to greater strength and rigidity, in spite of being unusually light. By this construction and the placing of various parts of the car frame relatively closer together, where necessary, in order to decrease the length of beam span, the car body structure is said to have even less deflection than previously encountered with steel cars.

The car is of relatively low height so that its body contour will mate in readily with a self-propelled unit or with other cars, at the same time providing ample head room and space within the car body. The rear end is streamlined, the front, or vestibule end, being made with a flush side door and designed for a flush connection with any car placed ahead of it in order to reduce wind resistance. Provision has been made for the subsequent extension of the side girder sheets below the side sills in the form of a skirt, if desired, thus providing an additional streamlining effect. Ventilators also are streamlined and all contours are smooth and true, contributing to the general appearance of the car, the exterior of which is scratch-brushed and waxed to give a silvery satin finish.

Interior arrangements and decorative treatment.

The interior of the car is of the « Modern Empire » mode of decoration or finish. As shown in the floor plan, the car is divided into a 25-foot section, seating 28, in the front end, a 10-foot buffet, a double card section, seating 8, and a parlor section, seating 14, in the observation end. Two fully equipped and attractively decorated wash-rooms are provided at the front end of the car and two similar wash-rooms between the buffet and the parlor for the use of passengers in this section.

The interior architectural treatment is based on columns from the base board to ducts extending along the car sides at about the height of the eaves. These ducts present the form of a header and are the receptacles for lighting fixtures, which are a part of the indirect lighting system. In the forward or coach section, the wall colors are aluminum and gold-aluminum shades with an extended dentil frieze. The ceiling is of the overlapping panel type, running the entire length of the section. The color scheme in creams and yellows produces uniform

light from the side, where the indirect light is located, to the longitudinal center.

The floor covering consists of a black marbleized rubber tiling. The double coach seats, with fixed, semi-reclining backs, are built of rectangular drawn aluminum tubing, which presents a polished framed edge for the reception of the upholstery. The upholstery is free from springs and cushioned by rubberized hair with means for holding the material taut and keeping the padded portions in their normal position. The attractive jade green frieze of the seat covering harmonizes with the green and gold damask curtains. More than the usual space is provided between the seats and this permits the insertion of removable tables on which meals may be served.

The enlarged buffet in the center of the car is fully equipped and provided with a novel type of oil-burning range, thoroughly insulated, and fired by oil fed to a special firebox in an amount dependent upon the quantity of air supplied by the blower. This is adjusted

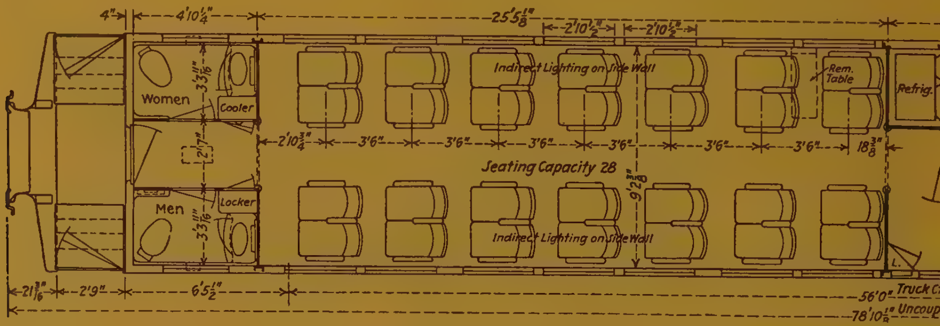


Fig. 3. — Floor plan of the aluminum observation coach desi

to produce a temperature of 450° F. in the ovens. Provision is made for the easy removal of the burner, blower and fire bricks and the insertion of grates for coal or briquettes, if desired. The exterior of the range is of polished stainless steel harmonizing with the interior finish of the buffet. Special attention has been given to the ventilation of the buffet and the removal of heat from the range. Buffet refrigeration for both the ice boxes and the soda-water fountain is of the mechanical type.

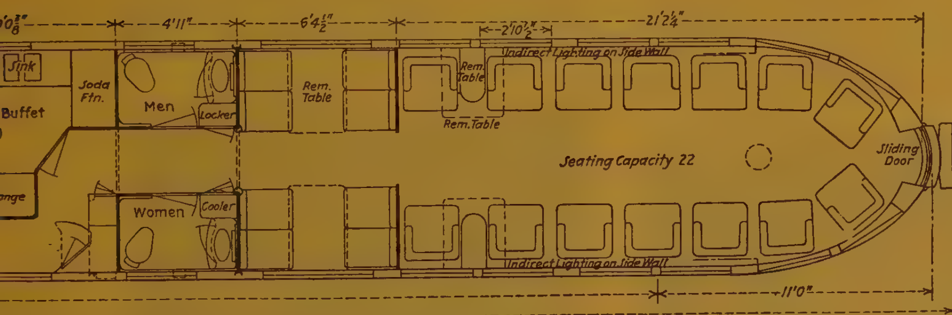
In the parlor section, the same general architectural design is used as in the coach section, but the column cornices and individual lighting ducts or frieze present a polished black surface, with polished aluminum moldings and projecting stars to relieve these surfaces. In the main body of the parlor section, the floor is covered with a two-tone rug, in keeping with the color scheme of the section. The portable seats, 14 in number, are upholstered in rust colored frieze, matching the rust and gold damask of the curtains. Between the window tops and the cornice containing the indirect light, mythical or allegorical plaques have been applied at the window sections. The ceiling is of the same type as described for the coach end, although it is continuous from the rectangular or straight-line surface of the side, proceeding in sweeping curves to give a dome effect at the observation end of the car.

The air-conditioning system.

The air-conditioning system, which is the latest development of the Pullman Car & Manufacturing Corporation, provides for cooling or heating these cars to a comfortable temperature, as weather conditions require. Proper ventilation is secured by forced circulation of filtered air, a sufficient proportion of which is fresh.

In train operation, the compressor is driven directly from the car axles by a series of power transmission devices. In station or yard service, the compressor is driven from an a.c. motor, obtaining its power from the outside source. With this arrangement, the compressor can be driven with a minimum of power losses en route, since the losses incident to generators, motors and batteries are eliminated. In station service, the a.c. power is the cheapest obtainable.

The air-distribution system is of the type commonly known as the bulkhead delivery type. The coach and the lounge sections are each supplied with cooled or heated air by individual units



...d built by the Pullman Car & Manufacturing Corporation.

with the air blown into the rooms through grills over the passage opening at one end of each room. The arrangement of both units is similar, each having a fresh air intake with a filter in the side of the deck and a recirculated air grill and filter in the passageway ceiling. Air is drawn in through these intakes by a motor-driven blower fan and passed over the cooling and heating coils, then through the grill into the car body.

The heating system combines floor heat and overhead heat. Since the ventilation system depends upon drawing in fresh outside air and circulating this in the car, it is necessary to heat or temper this air during cold seasons. A heating coil adjacent to the evaporator gives sufficient heat to the air to do most of the heating by this method. Only sufficient of the conventional floor-type heating coils are used to avoid cold floors and to help maintain a uniform temperature at all levels.

The control of the entire system, heating and cooling, whether en route or in stations, is simple and fully automatic. Only two switches and four thermostat switches need be set to control the fan, cooling system and heating system or to select the desired temperature for any season of the year. The entire system comprises a minimum of parts and is unusually light in weight. Aluminium is extensively used for such parts as supporting members, condenser frame and fans.

Trucks especially designed for easy riding.

The four-wheel trucks are of the built-up type, with aluminum side frames. Special provision has been made in the design to assure easy riding and rubber is used at various points to provide an additional cushioning effect. The journal boxes are of aluminum sheathed in steel to reduce wear. Brake rigging parts are made of aluminum, the brake beams being die forgings. Owing to the light weight of the car, it has been possible to use 4 1/4-inch by 8-inch journals with 33-inch rolled-steel wheels. The truck center plates are a recent development, in which, contrary to the usual practice, the recessed plate is inverted

Fig. 4. — The seating arrangement in the coach section.

Fig. 5. — Seating facilities and decorative treatment in the parlor section.

and does not form a receptive cavity for grit and dirt. This construction, in conjunction with self-lubricating liners, greatly facilitates free swiveling of the trucks.

Cast-steel couplers are used in conjunction with aluminum coupler yokes. Rubberized draft gears and buffing devices are used, being designed for high impact capacity and smooth, soft action throughout the entire range, with absolute absence of metallic contact at any time. The extreme movement in draft is 1 1/4 inches with a 2-inch movement in buff, resulting in a reduction of movement between the cars. Due to the nature of the gears, slack or lost motion is eliminated at all times.

Construction of the aluminum frame and superstructure.

The underframe is built of strong aluminum alloys, of suitable ductility. Stress-bearing members, whether their function is to take care of draft, buff or straight or combined loading, are of the continuous type. The center sill is of the straight-line type, with channel-shaped diaphragm spacers extending from vestibule end sill to a point beyond the bolster, of a length sufficient to compensate for shear action and to distribute properly the buffing stresses. Contrary to the usual practice, the cross bearers are continuous and so spaced that the load from the floor and center-sill sec-

tion is transmitted uniformly to the side-frame members. A unique design of diagonal bracing is used to tie in the side-sill members to the center-sill structure.

A single body bolster is used, of conventional construction, made of top and bottom cover plates, with pressed diaphragms properly framed into the center-sill members. Draft and buffer castings are of heat-treated strong aluminum alloys, and wear portions are provided with steel chafing plates, with the exception of the cavities through which the buffer stems operate. These are provided with removable Pullmanite bushings, which fit closely around these stems, and keep the lost motion at a minimum.

Fig. 6. — A portion of the underframe at the rear end of the car.

The superstructure represents a car of conventional width, but considerably less height than usual and an arched roof. The side-frame structure has as its essential feature framing members of extruded metal shapes in place of the ordinary pressings. The belt rail is an extruded metal shape running the entire length of the car. The ordinary letter-board member is used, but at the bottom of this member is an extruded metal section which acts as a stiffener. The pressed carlines are of channel sections, framed into an eave member resting on top of the post cap and riveted to the two vertical legs of this member. Taking into account the close fits permissible with the extruded metal sections, the whole side frame and roof structure can be likened to a unit structure, due to the continuous length of the sections.

The front end is of the usual type with a relatively flat end, designed primarily for future application of an envelope, which would entirely close in the opening at the sides between this and a forward car, to give a streamline effect. The body end sill is of U-shape, with anti-telescoping plate at its inner upward face, extending inwardly on the underframe.

The rear end has a parabolic contour in both the horizontal and the vertical sections. At the extreme end an opening is provided as an emergency doorway with double sliding doors. The framing is arranged to perform the same functions as provided in the vestibule end. Hairfelt type of insulation is used in the car.

The sash in this car are all of the stationary type, being flush with the outside surface of the car, built up of extruded metal sections, welded into a one-piece frame. The glazing strips are also of extruded metal of wedge type, permitting any desired pressure to be exerted on the rubber glazing member. The glass may be removed from the inside without removal of the sash. A ventilator is applied in the bottom rail of each sash, streamlined on the outside and of the rotative type.

The aluminum doors, of the non-pinch type, are built up by welding extruded rectangular box-type sections into one-piece frames and spotwelding panelled sheets into this main framing member, making a light and exceedingly strong door of few parts which promises minimum maintenance and long life. Counterbalanced trap doors of similar construction are provided.

Platform construction to reduce noise and eliminate dirt.

The platform arrangement is based: first, on increased protection and smoothness of action under impact and coupling; second, elimination of noise; and, third, reduction of air drafts prevalent on vestibule platforms with the consequent snow, dirt, etc.

These objectives are accomplished by use of the rubberized draft gear and buffing devices mentioned; also the side and center buffer stem construction. Diaphragm face-plate noises are overcome by counterbalanced springs which positively support these members, holding them in an upward position, rather than permitting them to work up and down. A special type of hinged foot plate and one-fold diaphragm, in contact with the foot plate and used in conjunction with thoroughly weatherstripped trap doors and vestibule side doors, prevents draft and the consequent infiltration of snow, cinders and dirt. All moving parts underneath the underframe portion of the car have been thoroughly cushioned by the use of rubber devices to kill sound and stop vibration.

[621. 392 (45+.62) & 625. 26 (.45+.62)]

Rolling stock repairs by welding.

(*The Railway Engineer.*)

Current welding practice on the Egyptian and the Italian State Railways, described hereafter, goes beyond that of the British railways in two notable respects, namely, the repairs to axle journals at the Bulak works of the former and the building-up of tyre flanges by automatic welding at the Florence shops of the latter. Although development in welding has advanced enormously in recent years, especially in North America, Germany and Australasia — arc welding is the eighth largest industry in the U. S. A. — we in Great Britain are still extremely cautious in our attitude to this science. This attitude has undoubtedly been fostered by certain failures subsequently traceable to faulty materials and workmanship rather than to any inherent defect in the practice of welding. Further, the failure of certain welding repairs not properly susceptible to this treatment has tended to bring fusion welding into unmerited disrepute. The situation is improving, however, and it is being recognised that welding must not be undertaken except by trained operators using the best materials under efficient control. Among difficulties that beset the designer and the field engineer in connection with welding, the following may be emphasised : (1) Latent stress; (2) inspection and testing of welds; (3) mechanical properties of weld metal. The question of latent stress is usually considered from the viewpoint of possible stresses in the frame as a whole. Once the design is approved the erector has still to ascertain, largely by trial and error, which members it is safe to cramp and the best sequence in which to join them. He has also to devise methods of turning contraction stresses to account by giving them useful (straightening or cambering) work to do. These difficulties are yielding to attack. Skilled welders can, for instance, run continuous beads along large panels without distortion, or make up a 60-ft. circle of steel plate and keep it flat. Recent investigation has shown that in cases of distortion the cause may lie in the relief of rolling stresses in the sections themselves by the heat evolved in welding.

The possibility of induced, as distinct from residual, stresses in the individual members, has also to be considered, and opinion in this country is at present generally opposed to experiments upon the more vital components of locomotives and rolling-stock. The welding of worn journal fillets and axle seats on the Egyptian State Railways is a comparatively simple and harmless operation, both in itself and from the fact that with the exception of, say, brake rigging, the factor of safety in straight axles is greater than in any other member. Good materials, skilled welding — we were much impressed on a recent visit to the Bulak works at Cairo by the excellent workmanship of the Egyptian operators — and reasonable control of the cooling rate of the weld zone provide adequate insurance against mishap so long as the axle is a good one and is subjected to satisfactory tests, such as electro-magnetic crack tests, before being put into service. The latter protection applies equally to unwelded axles in any case where heavy-duty vehicles are concerned. In the course of years the origin and identity of axles and blooms grows

uncertain; their duty becomes yearly heavier under more intense traffic; specifications change and inspection is tightened up, but the axles of 20 years ago, though forgotten, are still in service. There is always the possibility of a soft axle coming up for repair which may already be predisposed to incipient cracking in the wheel seat. With or without such predisposition, the development of a crack in the deposited layer is capable of extensive progression into the axle itself. Further stress, such as might be due to a more extensive repair than usual, is liable to become a determining factor of failure in the journal or at the wheel seat. Any or all of the foregoing objections could be put forward in the case of any important welding job. The fact remains that some 400 axles have been built up at the Bulak works over a period of three years without a single failure having occurred.

That the building-up of tyre flanges on the Italian State Railways is confined to carriage and wagon repairs is probably due to the recognition of the comparatively low factor of safety of tyres. The issue here is clear and is almost entirely a question of the permissible superposition of welding stresses upon residual (rolling and quenching) stress in the tyre. Before the installation of the plant described, extensive experiments which have been carried out clearly indicated its justification. It might be mentioned that the building-up of flanges on tramcars has been successfully practised for some considerable time in Italy. The enterprise of those responsible for rolling-stock maintenance on the State Railways of Italy and of Egypt is to be commended, and may eventually prove to have been an important step towards opening up fresh fields of economy.

(Editorial, *The Railway Engineer.*)

* * *

It happens frequently that when a wheel has to be returned on account of the flange being unduly worn, it is necessary to turn a large amount off the tread in order to get sufficient thickness of flange again, although if the tread alone had to be considered a very small amount of returning would suffice, or even none at all. This not only means waste of useful and expensive material in the course of turning, but it shortens the working life of the tyre materially, as the operation cannot be carried out more than a few times without reducing the thickness of the tyre below the permissible minimum, when it has to be rejected altogether.

The Italian State Railways have adopted electric-arc welding for building up the worn flanges of carriage and wagon wheels, and have installed apparatus at Florence capable of dealing with 2 400 tyres annually. It is expected that a net saving of about 126 000 lire in the same period will be realised. The demand amounts to about double this number of tyres, and a second set of equipment is to be installed at another suitable depot.

As yet the process has not been adopted for locomotive tyres, as it has been found that owing to the presence of the counterbalance weights and cranks with consequent uneven distribution of metal round the wheel, the rate of cooling of the deposited material varies from point to point sufficiently to set up undesirable stresses in the tyres which might lead to failures in service. Experiments are being conducted with the object of overcoming this difficulty.

Description of welding apparatus on the Italian State Railways.

A description of the method used by the Italian State Railways is given by our Italian contemporary, *La Tecnica Professionale,* and we are indebted thereto for the particulars we now present.

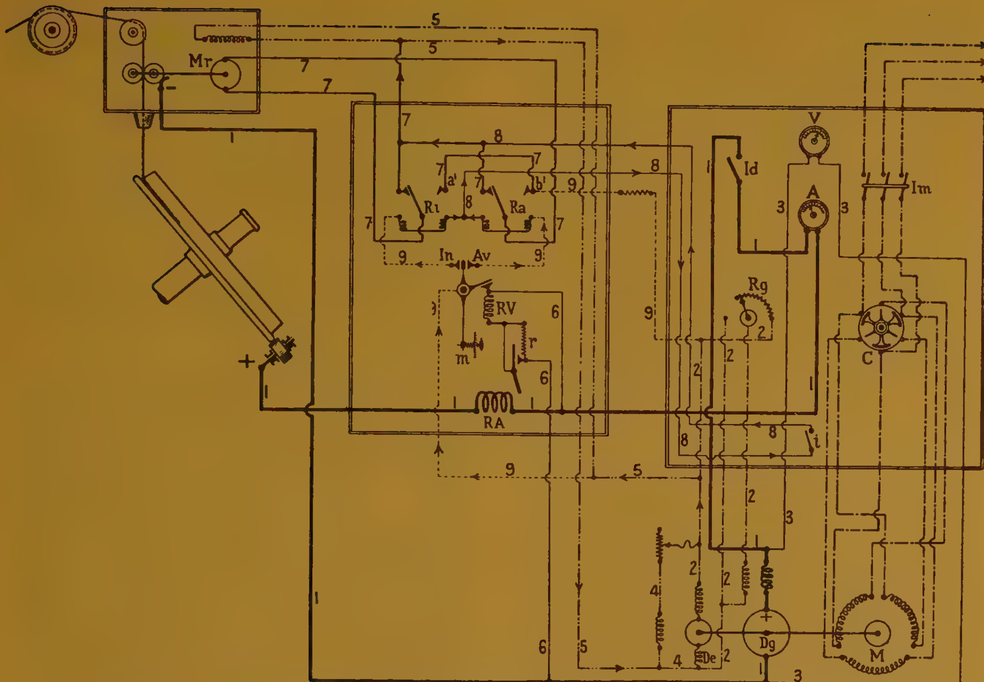


Fig. 1. — Electrical connections of tyre-welding installation, Italian State Railways.

The machine has been arranged, as the accompanying diagram (1) shows, so that the axle being treated is set at an angle and one tyre is dealt with at a time, this being considered to give better results than when the horizintal arrangement is used, in spite of the fact that two tyres can then be dealt with simultaneously, as the flow of the metal can be more easily regulated. The welding heads, of which two are used placed a short distance apart on the cicumference of the wheel, are carried on a light frame-work of angle irons with a runway beneath, on which a carriage moves. To this the axle is clamped. There is, of course, a switchboard equipped with the necessary control apparatus, and a motor for rotating the wheels and applying the scraper brushes to the tyres before welding is commenced. The circuits can be followed by reference to the figure.

The arrangement consists essentially of the three-phase motor *M* taking current from the supply mains and coupled to a direct-current generator *Dg*, 30 to 45 volts, 200 to 280 amperes, an auxiliary dynamo *De*, 110 volts, for exciting the generator and working the motor *Mr*, which advances the electrode and is situated in the welding head itself. The three-phase feed has a main switch *Im* and a commutator *C*, giving star or delta connections to motor *Mr*, and there are the usual measuring instruments and resistances. The most important part of the control board is that governing the regulation of the arc, consisting of the series relay *RA*, in the main circuit dynamo *Dg*, a shunt relay *RV*, connected to

(1) Diagram in *La Tecnica Professionale*, January, 1933, page 11.

its brushes, with two relays *Ra* and *Ri* controlling the direction of rotation of motor *Mr*, which has separate field excitation. The positive role of the dynamo is connected to a contact brush, or roller, bearing on the wheel under repair. The working is as follows :

After the closing of the switch *Im* and operation of the commutator *C* the motor *M* is started up and drives generator *Dg*. Should the electrode be in such a position that no arc can be formed there will be no current in the main circuit and relay *RA* will not be energised, relay *RV* alone receiving current. Contact *Av* will be closed, in the circuit of the coils of *Ri* and *Ra*. The latter will attract its armature to contact *b*1 and close the circuit to motor *Mr*, causing it to advance the electrode. In the opposite case, when the electrode is already in contact with the tyre, a heavy current will flow in the main circuit immediately, *Rv* and *Ra* will both tend to be actuated, but the latter, in attracting its armature, will short-circuit the coil *r* and prevent the relay *RV* being strong enough to operate its armature, and this, being drawn by spring *m*, will close contact *In*. Relay *Ri* will now be operated and close a circuit feeding motor *Mr* in the opposite sense so that it moves the electrode away from the tyre and forms the arc. Relay *RV* therefore brings relays *Ra* and *Ri* into play according to the strength of the current in the main circuit, the adjustment being made by means of spring *m*. The arc thus regulates itself, and when the adjustment of relay *RV* is correctly set the armature oscillates normally between contact *Av* and a point between it and contact *In*.

Welding on Egyptian State Railways.

Welding, both oxy-acetylene and electric-arc, is now extensively used in the Rolling Stock Department of the Egyptian State Railways. There is an up-to-date oxy-acetylene welding shop at the Bulak works at Cairo. The oxygen is delivered into a container at 75 lb. per sq. inch pressure, whence it is led by a pipe line to the various welding points in the shop. Alternatively, it can be charged into standard cylinders at 1 500-lb. pressure. The acetylene is similarly conveyed round the shop by a pipe to the welding points.

Among the normal repairs carried out by oxy-acetylene welding are the following :

Repair of broken firehole rings, locomotive cylinders, vacuum chambers and cylinders; filling up worn link holes and building up ends of brake shafts and reversing shafts; general welding to all piping, copper and steel, including steam pipes, injector pipes and vacuum pipes; welding fractured cast-iron parts of steam railcars, such as bored guides, cylinders and components; welding aluminium crank cases, cast-iron horn cheeks and keeps, worn axlebox brasses, cracks in radius of flanges of copper fireboxes, oil cups on connecting rods; stopping up cylinder and horn-cheek holes in frames; filling worn parts of steam-regulator valves; building up regulator glands, worn motion-bar slippers, worn seating on injectors and ejectors and laps of copper fireboxes.

The repairs carried out by electric-arc welding include the following :

Building up piston-rod taper ends, cast-steel axlebox keeps, crossheads, worn brake-hanger brackets and hangers, wheel seats, worn cast-steel horn cheeks, wasted boiler foundation rings, smokebox tube plates, laps of steel fireboxes and casing plates round hand holes; welding fractures and worn parts of engine framing, broken cast-steel horn cheeks, broken webs on cylinders and stretcher castings, fractured motion plates and locomotive cylinders, broken wheel spokes, broken meshes in steel tube plates, split laps of boiler-plate and tube-plate flanges, flange patches on tube plates, broken

firehole rings; filling up pittings in boiler barrels; building up worn parts of connecting rods and straps, axlebox faces and worn rocker-arm faces.

In addition, the wheel seats of locomotive driving axles have been successfully built up. The first of these was done in 1929 after an experiment had been made with a scrap axle and a scrap wheel. The axle was reduced in diameter by 3/16 inch and the surface covered with metal from grade 6 electrodes. The wheel seat was then returned and pressed into the wheel centre, which had previously been cleaned out on a lathe. In this experiment the tonnage for (1) pressing on and (2) taking off were :

(1) At 3 1/2 inches a pressure of 100 tons was registered, the pressure gradually increasing to 150 tons by the time the wheel was in position.

(2) The starting pressure was 175 tons, decreasing gradually to 60 tons, after 1 1/4 inches of movement to 50 tons at 1 3/4 inches, to 20 tons at 2 3/8 inches, and 15 tons at 3 3/8 inches, when the wheel came off. The diameter of the wheel seat was 8 1/2 inches and its length 6 3/8 inches.

Since 1929, whenever locomotive axles have had to be withdrawn from the wheel centres (usually on account of the wheel being loose on the axle), the seats have been built up in this way and no failures whatever have occurred. Fourteen locomotives had been so dealt with up till the end of January, 1933.

For some time it has been the practice to fill up the inside and outside fillets of carriage-axle journals when they are worn. This has been done as standard practice since 1930, some 400 axles having been dealt with up till the present and not a single case of failure having occurred.

The experiments of the Egyptian State Railways with welding have been so completely satisfactory that it has now been decided to construct all-welded steel wagons, and the first is now being built. During a recent visit to the Bulak works at Cairo, we were struck with the excellence of the workmanship, of which we have seen nothing better elsewhere.

[621.39 & 656. 25]

Electric lamps for railway signals,

by Eugene W. BEGGS,

Commercial Engineering Department, Westinghouse Lamp Company, Bloomfield, N. J.

(From *Railway Signaling*.)

Railway signal lamps are designed to produce dependable light, efficiently and lastingly. The extent to which the manufacturer has achieved this aim has been largely limited by the lack of standardization. The manufacturer must produce a wide variety of lamps, numbering today some 131 different and distinct designs. In addition, many of these are made in four different voltages, others with a variety of bases, and still others with two or more filament constructions. Efficiency and long life are determined chiefly by materials and workmanship, but dependability in service is a joint responsibility of the user

and the maker, and is of the lightest order when the lamps are replaced on a systematic schedule.

It is impossible to avoid variation in the life span of each lamp and it is also impossible to guarantee that all lamps of a group will burn longer than some specified minimum period. The causes of variation in signal-lamp life can be divided into two main groups — physical and chemical. Of the physical factors the most important of all is the diameter of the tungsten filament wire. The tungsten filaments in signal lamps are controlled closely for this reason, but the wire-drawing departments are allowed a small commercial range for wire diameter, which amounts to high and low limits separated by a few hundred thousandths of an inch. These variations are determined by weight, not by micrometer checks — being expressed by the weight in milligrams of a 200-mm. length of wire.

Roundness of the wire is also vital because the radiating surface of an incandescent conductor-wire largely determines its operating temperature at a given amperage. Absolutely perfect wire cannot be produced, but variations of only a few millionths of an inch are tolerated.

Most filaments are today coiled on a mandrel of high-quality steel « piano » wire. The diameter of this wire and its roundness as well as its hardness must be controlled within narrow limits. A « 3 mil » mandrel used in coiling a filament for a small railway signal lamp, for instance, is permitted to vary from 0.002967 inch to 0.003033 inch, and the roundness tolerances are of about the same order, being less than one per cent.

These tolerances, which are extremely minute, are commercial tolerances for the manufacture of lamp filament and mandrel. Although they are extremely small, they contribute to variation in lamp life. Factors such as mandrel diameter determine the length of the filament in the finished coil. A variation of one per cent in length, i. e., mandrel diameter, causes a variation of almost ten per cent in burnout life.

Factors such as wire diameter and roundness, which contribute more directly to operating temperature, are much more critical. A variation of one per cent in wire diameter, unless otherwise compensated for, results in a variation of 25 per cent in life, which is the reason why these factors must be held to the limits given.

Naturally, the hardness of the mandrel and the tension on the wire and the temperature of the wire as it is spun into a coil around the mandrel will determine the amount of stretch of the tungsten wire and the degree to which it imbeds itself into the steel mandrel. These factors, of course, as well as the others just listed, are all interdependent — some tending to prolong lamp life; others tending to reduce it. The ultimate life obtained is determined by the operating temperature of the hottest spot of tungsten filament within the lamp. That temperature determines the speed at which tungsten metal vapor sublimes, from the incandescent wire and this rate determines the burning hours required for the wire to corrode at the critical point until it can no longer carry the current, and fuses through, to result in the failure of the lamp.

Besides these important physical factors described above, the chemical factors are not to be ignored. Although the atmosphere in which each tungsten filament operates is theoretically inert and chemically pure, nevertheless it is beyond the ability of man today to eliminate completely every last molecule of impurity sealed within each glass bulb. Quantities of water vapor (Water vapor is one of the most serious impurities encountered in the lamp business) and other deleterious gases, too minute to measure by quantitative analysis, are

serious factors in determining the operating life of each individual lamp.

In general, however, it has been found practicable to maintain the purity of filling gas to predetermined limits, to incorporate within the lamp bulbs a clean-up chemical « getter », and to assume infinitesimal variations in the amounts of injurious chemical materials within each lamp. On this basis, lamp life is calculated and filament designs are determined assuming that the product from the factory will vary, almost none at all as far as the quantities of injurious chemical factors that are present in the finished lamp, are concerned. Nevertheless, there is no question but that the variations that do exist are important factors in determining the shape of the mortality curve.

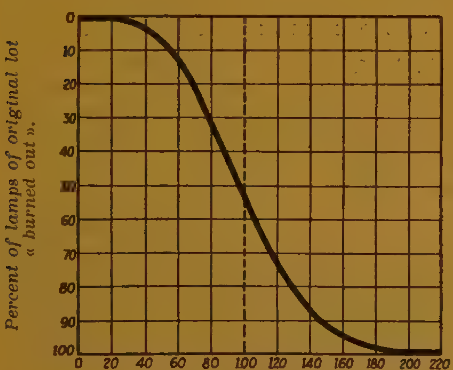


Fig. 1. — Typical mortality or « burn-out » curve for railway light-signal lamps, based on laboratory tests, and used in establishing lamp-replacement schedules. Curve shows that mortality data for lamps are similar to those for human beings. Curve ignores « infant mortality », because each lamp is given a short preliminary burning at the factory.

There are certain developmental chemical factors, however, which are less easy to control or to predict. In every batch of 1 000 lamps, for example, it is quite possible that one individual lamp may develop a small seepage of air through the fused glass seal. This seepage may be, and generally is, the result of shipping and handling and this particular lamp may deviate widely from the group and may become an early failure in service.

From these facts the mortality curve can be more readily understood, but there is one consideration of interest to railroad signalmen. The lamp manufacturer is committed to maintain as high a degree of life uniformity as he can possibly provide in his product. This means that he is extending every effort to make his product conform to the requirements of regular lamp-replacement schedules. He is trying to make the life of his lamp as nearly predictable as possible, so that his work will dovetail with the lamp-replacement schedules and lamp-maintenance operations of the railroad.

The so-called « life » of an incandescent signal lamp is the average life of large groups of that type of lamp when operated at its rated or « given » voltage. The actual average life of the product is determined by life tests which the manufacturer is continually making. Representative lamps from each lot coming off the production line are placed on test racks and burned until they fail. During these tests the voltage is maintained within a range of plus or minus 1/4 of 1 per cent. The number of hours the lamps burn is averaged and if there is a discrepancy, the quality of the product is investigated. Thus, these running tests enable the manufacturer to keep his lamp up to the standard of efficiency and rated life at the rated voltage.

The life of a signal lamp is based on that of a group, and represents neither a minimum nor a maximum. If one hundred lamps of 1 000 hours rated life are burned continuously on a test rack, at rated voltage, each individual lamp cannot be expected to burn out at exactly 1 000 hours. Actually, a small percent-

age of the lamps may fail in less than 400 hours; slightly more than half of the number will fail between 400 and 1 000 hours; and the remainder in from 1 000 hours upward. The majority, however, will fail near the average life of 1 000 hours.

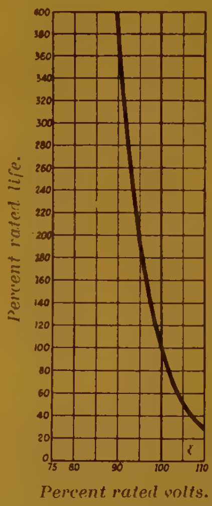


Fig. 2. — The extreme sensitiveness of lamp life to operating voltage is indicated by this volt-light curve for railway light signal lamps. As voltage rises the filament temperature also rises and speeds up the erosion of the tungsten wire. The per cent life shown is obtained with the voltage maintained constant throughout the life of the lamp.

A mortality or « burnout » curve for typical signal lamps (fig. 1) illustrates these facts. Here we see that 58 per cent failed at or below the rated life — 100 per cent. Average life, however, was normal because of those lamps which burned longer than rated life, some as much as 200 per cent. From this curve it is apparent that whereas the minimum life may be relatively short, comparatively few such lamps will be encountered, and if signalmen can arrange to renew the entire group relatively early in life, the outages in the signals can be held down to a gratifyingly low percentage. The *modus operandi* is like that of life insurance and is similarly certain. Because it is based upon laboratory tests, however, the mortality curve given should be followed as a guide to lamp replacement only with a considerable margin of safety.

Effect of applied voltage.

Since minimum hazard of dark signals is an important requirement, many railroads have adopted the policy of operating their lamps at an under-voltage in order to prolong the life. Obviously this practice is at the sacrifice of brightness in the indication. Only by close study can the railroads be assured that the lamps will not be operated so much under voltage as to reduce the indication to a dangerous point.

As indicated by the chart (fig. 2), reducing the applied voltage to ninety per cent of the rated voltage will increase the life of the lamps four-fold. This should, under ordinary conditions, provide sufficiently long lamp life to bring operating costs within reason, with a renewal schedule providing for lamp replacement at thirty per cent of average life. It is a critical balance that is required, but a replacement schedule of two or three lamps per socket per year seems quite practicable. With lamps of 1 000-hours « rated life » operating

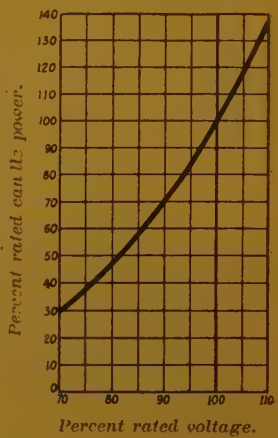


Fig. 3. — The volt-candle-power curve for railway light signal lamps shows that the light output of the Mazda lamp is critically affected by the voltage impressed upon it, and that extremely low operative voltages may become a menace due to reduction in the candle-power.

at a 90 per cent voltage and replaced after about 1 500 hours burning, indications should be clear and outages extremely rare. Where outage insurance must be still higer, three or more lamps

per socket per year should be the schedule.

In respect to the light output of signal lamps (fig. 3), a relatively small variation in applied voltage causes a large change. A variation as small as 1 per cent in applied voltage, for example, brings about a corresponding change of 3 1/2 per cent in light output. To operate a lamp at 90 per cent of rated voltage, then, would cause the candlepower output to drop to 70 per cent of the rated candlepower, with a correspondingly large loss in efficiency of candlepower per watt of power consumed. This loss in the reduced quality of indication is a factor which must be recognized as one which might affect the safety of those riding the road.

Double-filament lamps.

According to the mortality curve, signal lamps must be replaced considerably before average rated life has elapsed if outages are to be minimized. At what point lamps are replaced in present-day practice is governed by the policy of the individual roads, but the common point is 30 per cent of average life. Even under such practice, 5 per cent dark signals may occur. The one goal today of both lamp manufacturers and railway companies is to reduce this 5 per cent still further, and if possible, to obliterate it entirely.

With that goal in view, a new double-filament lamp is now undergoing tests. Operated at about 90 per cent of rated voltage under replacement schedules at 30 per cent life, it is expected to minimize further the danger or dark signals, yet without sacrificing quality indications by excessive under-voltage operation.

A secondary filament in this lamp is connected in parallel with the main filament and has a much longer rated life. Its sole function is to provide a short-range indication if the main filament should fail, and is designed to operate for a period long enough to permit replacement before the signal becomes totally dark. Since this minor filament will actually produce very little candlepower of itself, it wastes power. Some waste is expected of any « standby » device, but the new lamp can be operated so as to offset this. The facts can be obtained only after extensive tests, but it may be that it will be practicable to operate these lamps at a voltage nearer the rated voltage than has been safe with other types. If this is found to be the case, as is likely, then the greater efficiency of the lamp so operated, i. e., the increased candlepower per watt, will offset the power loss in the minor filament.

Analysis of those causes of lamp life variation resulting in actuarial information, such as the mortality curve given in figure 1, indicates that double-filament lamps are of little value where chemical factors are more potent than the physical factors. For this reason, double-filaments were, a few years ago, considered of less value than was necessary to justify their higher cost. Recent investigation has disclosed that the progress made within the last two or three years in lamp manufacture and increased knowledge of lamps on the part of the signal-lamp maintainer, have tended to reduce the importance of chemical factors. For this reason, the double-filament lamp is again being considered as a practical device.

The chemical factors affect both the major filament and the minor filament, and, due to the fact that the minor filament is of smaller filament wire, these factors may,and often do, injure the minor filament more severely than the major filament. A standby filament is, therefore, of little value where chemical factors are serious and this consideration makes the new standby filament idea worth watching. It also requires that

extreme care in maintenance be taken not only to assure careful physical handling of the lamps but also to insure close examination of the filaments after they have been burned a few minutes in the final signal.

Field tests of lamps.

No amount of perfection in lamp design by the manufacturer can ever hope to surmount the many contingencies of actual service. Minimizing these factors by close inspection is vastly important in the efficient operation of signal lamps. For example, lamps often develop weak filaments and air leaks in shipment and handling. To eliminate these lamps, a preliminary burning test of all lamps at normal voltage is recommended. Lamp filaments are more fragile after being burned and for that reason burning tests should be made at signal locations. It is best practice to burn the lamps in the signals for 10 to 15 minutes and to detect symptoms of trouble by observation. Discoloration of the bulb or excessive brightness of the filament when normal voltage is applied, indicates possible short life. After the preliminary burning test, the filament should have a shiny surface. If it becomes discolored, the lamp may soon fail.

Signal lamps should never be stored in a damp place because the continued exposure to moist air deteriorates the basing cement and results in loosening of bases when the lamps are inserted into signal receptacles. After they have been in service for a considerable time, signal lamps should not be removed and then replaced, as this also tends to loosen the base. This slight handling might cause the filament to break, as filaments which have been in service become fragile. Where practicable, therefore, signal lenses and reflectors should be cleaned without removing the lamp. For the same reason each class of lamp should have its individual replacement schedule, instead of transferring separate lamps from one indication unit to another on signals having separate lamps for each indication.

Meeting adequately the needs of railroads, in increasing safe operating speeds and reducing the cost of transporta ion, are the primary objectives behind the perennial efforts of lamp manufacturers to improve life dependability, physical accuracy, light-source brilliancy and efficiency of their product. Yet the non-standardization continues to make necessary that manufacturers keep on tap, and up-to-date, too many types of lamps for the many designs used by American railroads today. Signal engineers are no doubt aware of this condition, and are just as anxious as the manufacturers to eliminate this unnecessary duplication of product. When the signaling fraternity can bring about greater standardization work along the lines already recommended from numerous quarters, the day of lower costs and higher levels of quality indication with signal lamps will soon become a reality.

[625. 232 (.42)]

New London and North Eastern Railway trains for tourist traffic.

With the object of providing new and up-to-date coaching stock for special tourist and excursion services, an entirely new type of train has been introduced by the London & North Eastern Railway to the designs of Mr. H. N. Gresley, the Chief Mechanical Engineer.

Five trains of this type have been constructed, each consisting of twelve vehicles. Each train is 677 feet in length and will carry 600 passengers; it is vestibuled throughout and its total weight is 338 tons. The train formation is as follows :

Open saloon car with brake compartment.		52 seats.
Open saloon car Open saloon car	articulated	112 seats.
Buffet car.		24 seats.
Open saloon car Open saloon car	articulated	112 seats.
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Buffet car.		24 seats.
Open saloon car Open saloon car	articulated	112 seats.
Open saloon car with brake compartment.		52 seats.

The underframes are of steel, and all the bogies are of the London & North Eastern Railway standard four-wheeled compound bolster type.

The bodies of the open saloons with brake compartment, and the buffet cars, are each 61 feet 6 inches long and 9 feet wide. The articulated vehicles consist of two bodies each 52 feet long and 9 feet wide.

The exterior finish of the train is a distinct departure from the Company's usual practice. Instead of the plain varnished teak, the body is painted London & North Eastern engine green up to the waist line and cream above, the roof being finished in white.

The body construction incorporates several novel features. Teak framing is employed, but instead of the usual teak panels the whole of the exterior body panelling is of plywood. The teak framework of the body has been designed to eliminate rebating as far as possible, thus reducing machining to a minimum.

The body floor boards are bolted direct to the steel underframe, no body cushions being employed.

The outer body side panels are of 1/4 inch water-proof plywood supplied

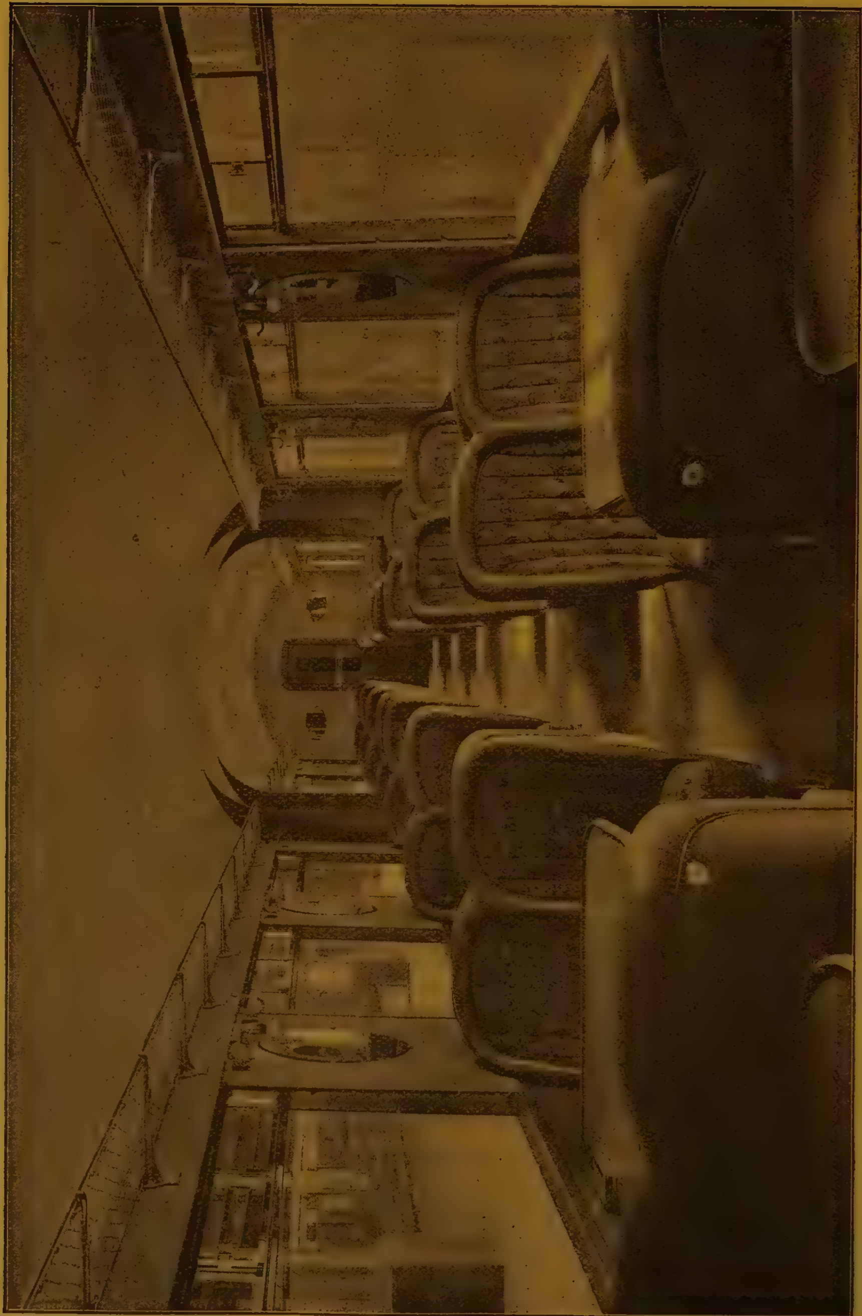
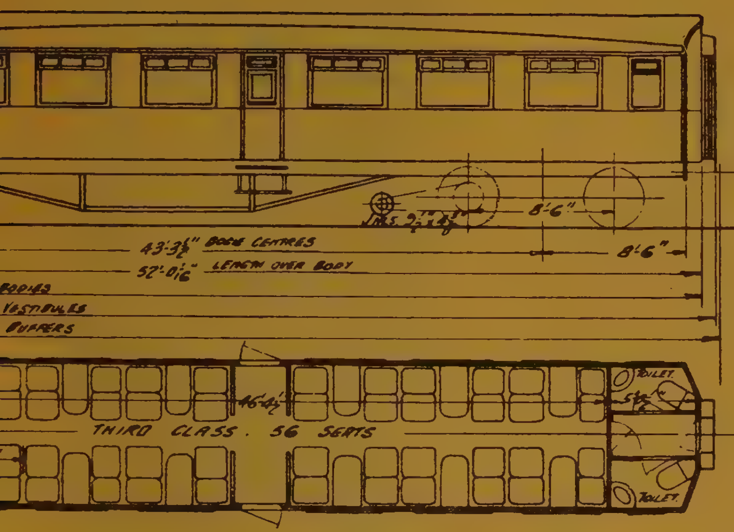
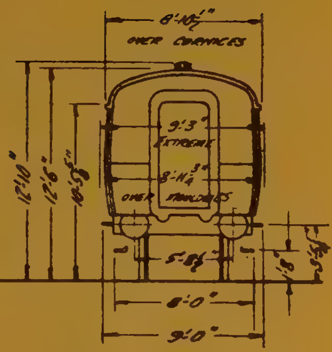


Fig. 1. — Interiof of open saloon car with semi-bucket type seats.

Fig. 2. — Interior of buffet car.

Figs. 3 and 4. — Twin c





Seats for 112 thirds.
Weight : 51 tons, 16 cwts, 1 gr.

rd class carriage.

by Messrs. Saunders-Roe Ltd. of East Cowes to the very large sizes of 25 feet long by 6 feet wide.

The face of all the body framing in contact with the plywood panels is covered with a special Rexine, the panels being bedded in chemical adhesive before being finally screwed into position; the window frames are Alpax die castings which are also bedded in chemical adhesive. The resulting structure is exceptionally strong and weather resisting and has proved to be very quiet when running.

The open saloons occupy practically the full length of each body and to compensate for the absence of cross partitions a steel stiffening rib has been introduced on either side of the centre doorway. The ribs are screwed to the main pillars, the lower ends being riveted to the underframe and the tops to strong angle hoopsticks.

The interior of the body is lined throughout with plywood with the exception of the ceilings which are of special millboard. The partitions are block plywood, the whole presenting a smooth surface for the application of the Rexine decoration. The interior walls and ceilings are covered with Rexine throughout the train, the colour schemes varying in the different types of vehicles. In the two outer saloons adjacent to the brake compartments, the walls from the floor to the waist line are covered with dark blue Rexine, the covering above the waist being a silver-blue Rexine having a fabric finish. The ceilings are of ivory Rexine.

The articulated units have been decorated to follow two colour schemes, one being brown, with Rexine in a dark brown hide effect below the waist line and light brown above, with a cream Rexine on the ceiling. The other is green with a dark green Rexine on the walls below the waist and a stippled grey above the waist, with cream Rexine covering the ceiling.

The blinds are of Rexine proofed on each side.

The colour scheme for one buffet car per train is blue below the waist line and silver grey above, and for the other car stippled blue below waist and gold above. All the windows in the buffet cars are fitted with blue poplin curtains.

The saloon floors have a covering of cork lino coloured to match the walls, and the buffet car floor is covered with blue « Korkoid ».

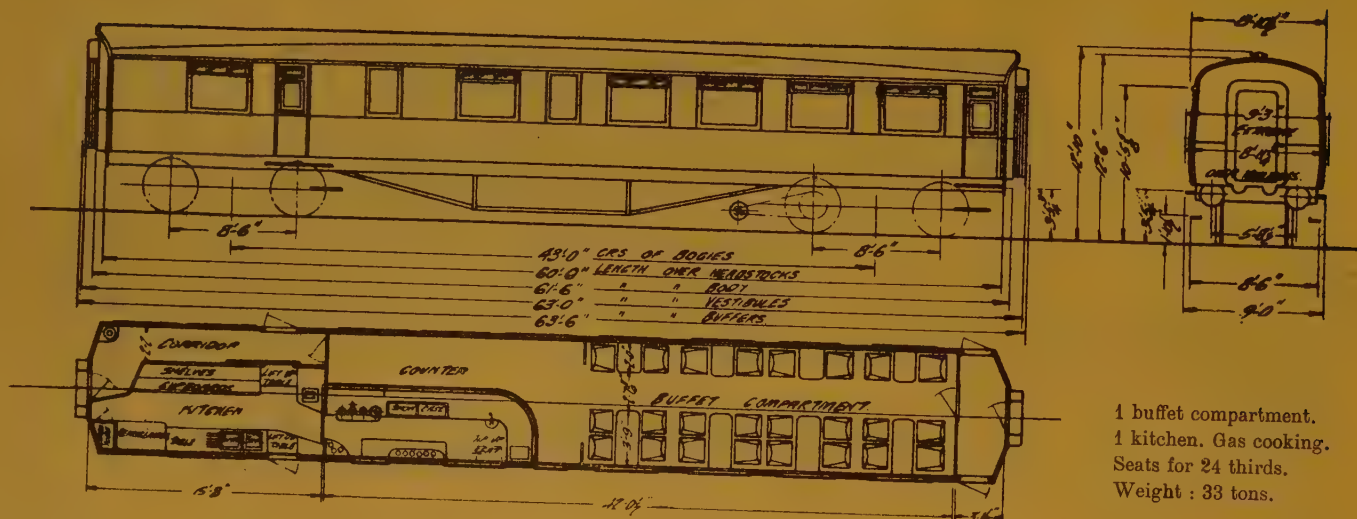
One of the most interesting innovations is to be found in the seats. The seats in all vehicles, except the buffet car, are of a greatly improved semi-bucket type and have been designed to give each passager a seat to himself with the maximum of room and the greatest comfort. They are upholstered in moquette and leather to harmonise with the colour scheme of the saloon, and are arranged in groups of four, two each side of a table, a centre gangway running the full length of the saloon. The seat cushions in some of the units have spring fillings provided by the Vi-Spring Company and in others the fillings are Latex supplied by the Dunlop Company. The introduction of this type of seat will raise the standard of travel comfort considerably, each passager having an individual seat which is numbered and can be reserved.

The buffet car chairs are movable and are of chromium plated tubular steel, the seat and back being upholstered in Rexine.

Accommodation is provided on each buffet car for 24 passengers, two seats to each small table at one side of the gangway and four seats to each large table at the other side. The tables are chromium plated with tubular legs, the tops being covered with black « Korkoid ».

A counter is situated at one end of the car at which refreshments can be obtained, the counter being fitted with a special glass showcase. Tea and coffee is provided by means of a Still's automatic boiler. Adjacent to the counter is a spacious pantry which in addition to the large storage cupboards and sinks is

Fig. 6.



1 buffet compartment.
1 kitchen. Gas cooking.
Seats for 24 thirds.
Weight : 33 tons.

Figs. 5 and 6. — Buffet car.

Fig. 7.

To carry
10 cwts. of luggage.
Seats for 52 thirds.
Weight : 32 tons, 2 cwts, 3 qrs.

Fig. 8.

Fig. 7 and 8. — Open third class brake.

equipped with a small grill and gas ring. To ensure that food supplies are kept fresh an electrically operated refrigerator is also provided.

The prevailing note in the decoration of the train is modernity in colouring with simplicity of line. The use of mouldings has been reduced to a minimum; the walls are plain and there is no decoration of any kind on the roof. The resulting effect is entirely successful and has given a sense of spaciousness quite unusual in railway stock built to the limitations of the British loading gauge.

Oval frameless mirrors are fixed on each side and end quarter of the passenger saloons. The luggage racks, hat and coat hooks, ash trays, side electric light brackets and door fitments in the saloons are chromium plated. Metal fitments below the waist line of the body are cellulose finished in a colour to match the decoration scheme and all roof ventilators and roof lighting fittings are finished to match the roof.

Ample lavatory accommodation is provided on the train, two toilet compartments being situated at the end of each open saloon and so arranged that when the complete train is assembled, four of these are adjacent to each other.

The toilet walls are covered with grey Rexine and the ceilings with ivory Rexine. The Korkoid floor covering matches the grey of the walls and all fittings are grey cellulose finished. Hot and cold water apparatus is fitted to all washbasins.

The train is steam heated throughout, radiators being fitted the full length of the saloons along the body side.

The electric lighting is of the Stone's double battery type, the main saloon lighting being provided by a 40-watt Opal roof lamp in each section with an additional 15-watt lamp over each mirror on the body side. The roof lamps in the buffet cars are 60-watt.

The trains provide a new standard of comfort for the travelling public and will form an important addition to the stock of the London & North Eastern Railway Company.

[385. (06. 111]

OFFICIAL INFORMATION

ISSUED BY THE

PERMANENT COMMISSION

OF THE

International Railway Congress Association.

Meeting of the Permanent Commission, held on the 29 July 1933

The Permanent Commission of the International Railway Congress Association met on the 29 July last at the Headquarters Offices of the Belgian National Railway Company.

* * *

Mr. Foulon, President, was in the chair. He confirmed the statement he made at the Meeting held by the Permanent Commission on the 30 January, regarding his retirement from the position of General Manager of the Belgian National Railways, and he informed the Meeting that he wished to relinquish the Presidency, which he had agreed to hold until that day. Having thanked his Colleagues of the Permanent Commission for the confidence and the good feelings they had shown to him during his tenure, as well as the Secretariat's Office for their cordial collaboration, Mr. Foulon proposed as President Mr. Rulot, his successor as General Manager of the Belgian National Railway Company, who, in his opinion, was in every way qualified to take his place in the Congress Association.

After addressing a vote of thanks to Mr. Foulon, the Meeting elected Mr. Rulot as President by acclamation. Mr. Foulon then left the Chair to Mr. Rulot who thanked the Members for their sympathy and assured them he would endeavour to fulfil his mandate as efficiently as his predecessor.

* * *

The Meeting then dealt with the cancellation of some mandates of Member of the Permanent Commission and the replacement of resigning members.

The three Canadian Railway Administrations who formerly belonged to the Association having all resigned recently, it was reluctantly decided that the three mandates hitherto allotted to that country should become vacant.

These three members were Sir George McLaren Brown and Mr. Clews, who both resigned recently, and Sir Henry Thornton, who died in 1932.

The Meeting then elected as Members of the Permanent Commission :

Mr. Rauscher, Ministerial Councillor, Commercial Manager of the Austrian Federal Railways;

Mr. Léon Jacobs, General Manager of the Belgian National Light Railway Company;

Mr. Gufflet, General Manager of the Midi Railway Company (France), and

Mr. VERKOYEN, Chief Mechanical Engineer, Belgian National Railway Company.

These Gentlemen replace Messrs. SEEFEHLNER, CAUFRIEZ, PAUL and FOULON who resigned as a result of a change in their official position (Art. 6 of the Rules and Regulations).

Furthermore, a mandate allotted to Egypt and left vacant up to then was filled in by the appointment of H. E. Mohamed OSMAN Bey, Under Secretary of State, Ministry of Communications, Cairo.

* * *

The statement of receipts and expenditure for the year 1932 was approved by the Meeting; the provisional budget drawn up for 1933 showed that, despite the heavy expenditure caused by the Organisation of the recent Cairo Congress, the financial position of the Association was quite satisfactory.

The rate of the variable part of the yearly contribution, which was 0.15 gold-franc per kilometre of line for the year 1933, was reduced by 20 %, i. e. brought down to 0.12 gold-franc for 1934, the maximum laid down by the Rules and Regulations being 0.20 gold-franc.

* * *

Subsequently the Meeting dealt with the proposals presented to, and approved by, the Plenary Meeting of the Cairo Congress regarding the yearly publication of reports on questions of immediate interest to Member Administrations at the present time, and considered the steps to be taken in order to carry this resolution into effect.

A discusssion took place, the outcome of which was that two important questions will be made the subject of periodical inquiry and report for publication, early in 1934 and 1935, in the three editions (English, French and German) of the *Monthly Bulletin* of the Association. These questions are worded as follows :

1. — Rail motor cars from the point of view of their construction : Types of motors. Forms of transmission. Body design. Lighting, heating and ventilation. Speed caracteristics and carrying capacity, etc.

2. — The world crisis and the railways. Repercussion of the crisis on the working. Steps taken to lessen the consequences. Competition or collaboration between rail and road. Future developments.

New ideas in passenger traffic working (fast light trains between large towns and between large and small towns, train times at regular intervals).

It was also agreed that France and the United States of America would report on the first question, while Germany and Switzerland, England, Belgium and Italy would be asked to report on the second question.

Finally the Meeting decided that, for each question, a special account summing up the reports presented would be drawn up, with commentaries and summaries, and be published in the *Bulletin*, and that the various reports would be discussed at an enlarged Meeting of the Permanent Commission in 1935, at which Meeting the list of the questions to be brought up for discussion by the 1938 Congress would be drawn up.

* * *

The Meeting was informed of the circumstances which led the Executive Committee to cancel the contract entered into,

in 1928, with a Brussels firm for working the publicity department of the *Monthly Bulletin*, and of the arrangements made by them in order to take over this business.

* * *

The following changes took place in the Membership of the Association since the last Meeting.

A. — **GOVERNMENTS.**

The Governments of the United States of America and of the Dominican Republic have resigned.

B. — **ORGANISATIONS.**

The Railway Transportation Commission of the International Chamber of Commerce was admitted as a member of the Association.

C. — **RAILWAY ADMINISTRATIONS.**

The following Railway Administrations have resigned, the reasons given being the difficult financial position of the railways and the need for economies :

	Km.	Miles.
National Rys. of Mexico.	12 005	*7 460*
Kansas City Southern Ry.	1 356	*843*
North Western Railway of Uruguay.	182	*113*
Richmond, Fredericksburg & Potomac Railroad. .	188	*117*
Thessaly Railway . . .	233	*145*
Société des Transports en Commun de la Région Parisienne	1 010	*628*
Canadian Pacific Ry. . .	25 350	*15 752*
Canadian National Rys. .	38 251	*23 768*

The Meeting expressed much regret at these resignations and decided that the Administrations concerned would be earnestly requested to reconsider the matter.

At the present time, the Association is made up of 214 Railway Administrations working together 534 848 km. (332 345 miles) of lines. The number of affiliated Organisations is now 12.

P. Ghilain,
General Secretary.

N. Rulot,
President.

List of Members of the Permanent Commission

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

(29 July 1933).

President :

N. **Rulot** (3), directeur général de la Société Nationale des chemins de fer belges; rue du Progrès, 74, Brussels;

Vice-Presidents :

C. **Colson** (2), membre de l'Institut, inspecteur général des ponts et chaussées, vice-président honoraire du Conseil d'Etat de France, membre du Conseil supérieur des chemins de fer de France; rue de Laplanche, 2, Paris;

U. **Lamalle** (2), directeur général adjoint, directeur de l'exploitation à la Société Nationale des Chemins de fer belges; rue de Louvain, 17, Brussels.

Members of the Executive Committee :

The Right Hon. Sir Evelyn **Cecil** (1), G. B. E., privy councillor, director, Southern Railway (Great Britain); 2, Cadogan Square, London, S. W. 1;

P. E. **Javary** (1), directeur de l'exploitation de la Compagnie du chemin de fer du Nord français; rue de Dunkerque, 18, Paris;

D. **Vickers** (3), director, London Midland & Scottish Railway; Chapel House, Charles Street, Berkeley Square, London, W. 1.

Ex-presidents of sessions, members ex-officio :

The Right Hon. Viscount **Churchill**, G.C.V.O., chairman, Great Western Railway (Great Britain); Paddington Station, London, W. 2;

J. **Gaytân de Ayala**, ancien président du Conseil des travaux publics d'Espagne; Villa Ulialde, San Sebastian;

H. E. Ibrahim Fahmy **Kerim** Pasha, Minister of Communications of Egypt; Cairo.

Members :

R. H. **Aishton** (3), president, American Railway Association; 30, Vesey Street, New York;

W. W. **Atterbury** (1), president, Pennsylvania Railroad Company; Broad Street Station, Philadelphia, Pa.;

F. **Besser** (1), Ministerialrat, Reichsverkehrsministerium; Wilhelmstrasse, 80, Berlin, W. 8;

L. **Bochkoff** (2), ingénieur, directeur général des chemins de fer et des ports de l'Etat bulgare; Sofia;

J. **Castiau** (2), secrétaire général du Ministère des Transports de Belgique; rue de la Charité, 25, Brussels;

The Right Hon. Sir Evelyn **Cecil**, G. B. E., (already named);

H. E. Mahmoud **Chaker** Bey (3), under secretary of State, General Manager of the Egyptian State Railways; Cairo;

Chiossi (3), vice-directeur général des chemins de fer de l'Etat italien; Rome;

The Right Hon. Viscount **Churchill**, G. C. V. O. (already named);

C. **Colson** (already named);

R. **da Costa Couvreur** (1), ingénieur en chef de la division de la voie et des travaux de la Direction générale des chemins de fer, membre du Conseil supérieur des chemins de fer du Portugal; Bairros Sociaes, Arco de Cego, Rua A, No. 4, Lisbon;

Dautry (3), directeur général des chemins de fer de l'Etat français; 20, rue de Rome, Paris;

Sir Francis **Dent** (3), C. V. O., director, Southern Railway (Great Britain); Dock House, Beaulieu (Hants), England;

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(1) Retires at the 13th session.
(2) Retires at the 14th session.
(3) Retires at the 15th session.

Dr. **Dorpmüller** (1), Generaldirektor der Deutschen Reichsbahn-Gesellschaft; 35, Voss-Strasse, Berlin W. 9;

F. **Fiori** (1), ingénieur, administrateur des chemins de fer de l'Etat italien; Villa Patrizi, Rome;

M. **Fontaneilles** (2), inspecteur général des ponts et chaussées, président de la section des chemins de fer au Conseil général des ponts et chaussées de France, président du Conseil de réseau des chemins de fer d'Alsace et de Lorraine; rue de Sèvres, 4, Paris;

Sir Henry **Fowler** (2), K. B. E., assistant to vice-president (research and development), London Midland & Scottish Railway; Derby;

J. **Gaytán de Ayala** (already named).

P. **Ghilain** (2), ingénieur en chef au service du matériel de la Société Nationale des chemins de fer belges; rue du Progrès, 74, Brussels;

A. **Granholm** (2), directeur général des chemins de fer de l'Etat suédois; Stockholm;

H. N. **Gresley** (2), chief mechanical engineer, London & North Eastern Railway; King's Cross Station, London, N. 1;

Grimpret (2), conseiller d'Etat, directeur général des chemins de fer au Ministère des Travaux publics de France; 244, boulevard St-Germain, Paris;

Ch. **Gufflet** (3), directeur de la Compagnie des Chemins de fer du Midi; 54, boulevard Haussmann, Paris;

R. J. **Harvey** (3), consulting engineer to the Government of New-Zealand; 34, Victoria Street, Westminster, London, S. W. 1;

Henry-Gréard (3), directeur de la Compagnie du chemin de fer de Paris à Orléans; rue de Londres, 8, Paris;

H. **Hunziker** (1), ingénieur, directeur de la division des chemins de fer du Département fédéral des postes et des chemins de fer suisses; Berne;

Sir Cyril **Hurcomb** (1), K. B. E., C. B., secretary to the Ministry of Transport (Great-Britain); 6, Whitehall Gardens, London, S. W. 1;

Jacobs (1), directeur général de la Société Nationale belge des Chemins de fer Vicinaux; 14, rue de la Science, Bruxelles;

A. **Jacques** (1), directeur de la Voie à la Société Nationale des Chemins de fer belges; rue de Louvain, 17, Brussels;

P. E. **Javary** (already named);

H. **Jezierski** (1), conseiller ministériel au Ministère des Communications de Pologne; Warsaw;

E. **Kejr** (3), ingénieur, conseiller des constructions du département V/1 au Ministère des chemins de fer de Tchécoslovaquie; Prague;

H. E. Ibrahim Fahmy **Kerim** Pasha (already named);

D. **Knejevitch** (2), directeur général adjoint des chemins de fer de l'Etat yougoslave; Belgrade;

P. **Knutzen** (3), directeur général des Chemins de fer de l'Etat danois; Sölvgade, 40, Copenhague, K.;

U. **Lamalle** (already named);

L. F. **Loree** (3), president, Delaware & Hudson Railroad; 32, Nassau Street, New York City;

A. **Mange** (1), administrateur de la Compagnie du chemin de fer de Paris à Orléans, président du Comité de gérance de l'Union internationale des chemins de fer; rue de la Bienfaisance, 42, Paris;

C. **Marchi** (1), député au Parlement italien, président général de la Confederazione Nazionale Fascista delle Imprese di Communicazioni Interne; via Quattro Fontane, 149, Rome;

(1) Retires at the 13th session.
(2) Retires at the 14th session.
(3) Retires at the 15th session.

M. **Margot** (3), directeur général honoraire, conseiller de la Compagnie des chemins de fer de Paris à Lyon et à la Méditerranée; rue Saint-Lazare, 88, Paris;

A. **Marguerat** (1), directeur des Compagnies de chemins de fer de Viège à Zermatt, Furka-Oberalp, Gornergrat et Schöllenen; Lausanne;

E. **Maristany** (3), marquis d'Argentera, directeur général de la Compagnie des chemins de fer de Madrid à Saragosse et à Alicante; Estación de Atocha, Madrid;

C. **Mereutza** (2), directeur général des Chemins de fer de l'Etat roumain; Bucarest;

G. **Molle** (1), secrétaire technique à la Direction générale de la Société Nationale des chemins de fer belges; rue de Louvain, 17, Brussels;

L. **Moralès** (2), vice-président du Conseil supérieur des chemins de fer d'Espagne, président du Conseil d'administration des chemins de fer de l'Ouest de l'Espagne, Estación de las Delicias, Madrid;

J. **Moreno Ossorio** (1), directeur de la Compagnie des Chemins de fer du Nord de l'Espagne; Madrid;

Dr. T. **Ogura** (2), manager of the Office of the Japanese Government Railways; Friedrich Ebert-Strasse, 6, Berlin W. 8;

H. E. Mohamed **Osman** Bey (3), under secretary of State, Egyptian Ministry of Communications; Cairo;

Sir Frederic **Palmer** (3), C. I. E., consulting engineer, Office of the High Commissioner for India; 55, Broadway, Westminster, London, S. W. 1;

G. **Philippe** (3), inspecteur général des lignes Nord belges; Liége;

Dr. W. **Rauscher** (2), Ministerialrat, Kommerzieller Direktor der Oesterreichischen Bundesbahnen; Vienna;

P. **Riboud** (2), directeur de la Compagnie des chemins de fer de l'Est français; rue d'Alsace, 21, Paris;

† Youssef **Risgallah** Bey (3), member of the Board of Management, Egyptian State Railways, Telegraphs and Telephones; Cairo;

N. **Rulot** (already named);

de **Samarjay** (1), secrétaire d'Etat, président de la Direction Générale des Chemins de fer royaux de l'Etat hongrois; Andrâssy ut, 73, Budapest;

A. **Schrafl** (2), président de la Direction générale des chemins de fer fédéraux suisses; Berne;

Sir Josiah **Stamp** (2), G. B. E., D. Sc., chairman and president of the Executive, London Midland & Scottish Railway; Euston Station, London N. W. 1;

T. C. **Swallow** (3), advisory engineer, Office of the High Commissioner for the Union of South Africa; South Africa House, Trafalgar Square, London W. C. 2;

Antonio **Valenciano y Mazerès** (2), inspecteur général des ponts et chaussées, administrateur de la Compagnie des chemins de fer de Madrid à Saragosse et à Alicante; General Oráa, 5-3°, Madrid;

H. **van Manen** (1), directeur des chemins de fer néerlandais; Utrecht;

Th. M. B. **van Marle** (3), inspecteur général des chemins de fer et tramways néerlandais; Koningskade, 25, The Hague;

L. **Velani** (1), directeur général des chemins de fer de l'Etat italien; Villa Patrizi, Rome;

A. M. M. **Verkoyen**, directeur du Service du Matériel de la Société Nationale des Chemins de fer belges; 17, rue de Louvain, Brussels;

D. **Vickers** (already named);

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(1) Retires at the 13th session.
(2) Retires at the 14th session.
(3) Retires at the 15th session.
† Died in August 1933.

Sir Ralph Lewis **Wedgwood** (1), C. B., C. M. G. chief general manager, London & North Eastern Railway; King's Cross Station, London, N. 1;

D. **Willard** (1), chairman of the Board, American Railway Association; president, Baltimore & Ohio Railroad; Baltimore, Md.;

P. **Wolf** (3), Geheimrat, Direktor der Deutschen Reichsbahn-Gesellschaft und Mitglied des Direktionsausschusses dieser Gesellschaft; Voss-Strasse, 35, Berlin, W. 9;

K. Y. **Woo** (2), director of the European Bureau of the Ministry of Railways of the National Government, Republic of China; 41, rue de Liége, Paris;

N... (2) (Argentine);

N... (1) (Australia);

N... (1) (Brazil);

N... (2) (Germany);

N... (2) (Germany);

N... (3) (Germany).

Honorary member : Gustav **Behrens**, director, London Midland & Scottish Railway; 20, Chepstow Street, Manchester.

SECRETARY'S OFFICE : rue du Progrès, 74, Brussels.

General secretary : P. **Ghilain** (already named).

Assistant secretaries :

R. **Desprets**, ingénieur principal à la Société Nationale des Chemins de fer belges;

E. **Minsart**, ingénieur principal à la Société Nationale des Chemins de fer belges;

A. W. **Chantrell**, ingénieur principal à la Société Nationale des Chemins de fer belges.

(1) Retires at the 13th session.
(2) Retires at the 14th session.
(3) Retires at the 15th session.

ERRATA.

Bulletin, vol. XV, No. 8, August 1933.

Article : « *Gebus automatic control system* », page 763, first column, sixth line from the bottom, *instead of :* « B. H. P. per hour » *read* « lb. per B. H. P. per hour ».

Article : « *London & North Eastern Railway welded wagon underframe,* p. 789, 2nd column, third line, *instead of :* « The resultant saving in weight and », *read :* « The work was carried out at the ».

Article : « *Permanent way maintenance costs* », p. 791, first column, fifth line from the bottom, *instead of :* « to 15.55 d. per track mile », *read* « to 17.55 d. per train-mile ».